WORLD'S COLUMBIAN EXPOSITION

1893

AT CHICAGO

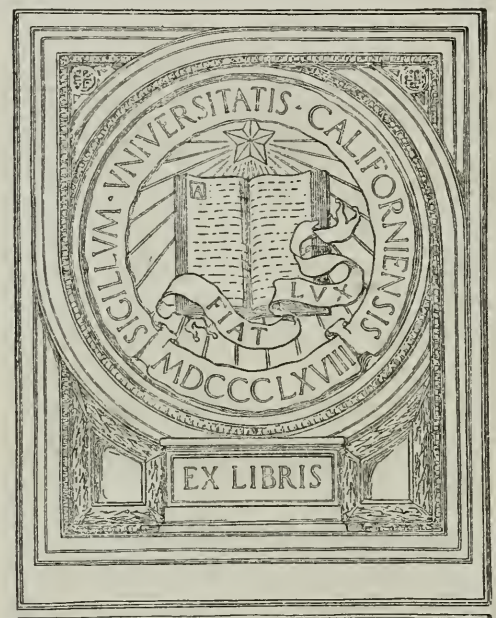
MINING AND METALLURGY

BY A. KEPPEN MINING ENGINEER

OF THE

MINING DEPARTMENT

MINISTRY OF CROWN DOMAINS



THE

INDUSTRIES OF RUSSIA

MINING AND METALLURGY

WITH A SET OF MINING MAPS

BY

A. KEPPEN

MINING ENGINEER

FOR THE

WORLD'S COLUMBIAN EXPOSITION

AT

CHICAGO

EDITOR OF THE ENGLISH TRANSLATION

JOHN MARTIN CRAWFORD

U S CONSUL GENERAL TO RUSSIA

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PREFACE.

The mining industries, which constitute one of the chief branches of national economy and whose products form the most important objects of national wealth and consumption, undoubtedly deserve special attention among the various branches of industry of the Empire.

The present review of the Russian Mining Industries was written for the World's Columbian Exposition at Chicago, 1893, and its main object is to acquaint foreign countries with the position of the industry in Russia. This work has been based upon the facts and data given in the official mining and metallurgical statistics annually published by the Mining Committee of Engineers, and the author has endeavoured to group these data in the clearest form possible and to elucidate them by giving the reasons which have brought the separate branches of the industry to their present position. Therefore, notwithstanding the brevity of the present review, it was impossible to neglect the historical side of the development of the mining industry in Russia. This side of the subject is both treated in the introduction and in the historical sketches of the rise and progress of the individual branches of mining and metallurgical works.

But as the statistical data alone of the production of the objects of this industry cannot give the possibility of form-

ing a conception of the extent to which the home industry corresponds to the national demand, inasmuch as this demand progresses and satisfies itself by interchange of these commodities with other countries, therefore the author has thought best to answer these questions by giving further data collected from various sources. And lastly, upon the suppositions that the acquainting of foreign countries with the position of the Russian mining industries may tend to incite commercial relations with other countries, which do not at present carry on any interchange with the products of the Russian Mining Industry, the author enumerates those countries which already participate in such interchange of trade, and cites the duties laid upon the importation of foreign products by the tariff of 1891. The extent of these duties also clearly indicates the protective policy required by each of the individual branches of this industry.

A. Keppen,
Mining Engineer.

PREFACE

TO THE

ENGLISH TRANSLATION.

A visit to the Imperial Hermitage at St. Petersburg will impress even a casual observer with the great variety and marvellous beauty of the jasper, porphyry, lapis lazuli, malachite and other semi-precious stones brought from the mines and quarries of the Empire to adorn the National Museum and Gallery of Arts. In like manner a visit to the Mineralogical and Mining museums of the Russian Capital will convince the specialist of the wonderful wealth of precious stones, noble metals, and other valuable minerals found in the different regions of this vast country.

In these pages Mr. A. Keppen, Mining Engineer, has given a scientific, interesting and very instructive resumé of the mining industries of Russia, together with an historical description of their birth and development in the several portions of the Empire: he has also given a detailed and carefully tabulated account of the commercial importance of the many products of the Russian mines, and with the aid of maps has carefully pointed out the most important localities of the principal deposits. In this work Mr. Keppen has been aided by the official figures of the Mining Department, Ministry of Imperial Domains.

In the editing of this translation I have sought to render the compound consonants of the Russian language, and especially

the geographical and other proper names, into English after a simple and uniform method. Therefore, case and gender endings, particularly of adjectives, have been dropped. To illustrate, the very common adjective terminations, *ской, ская, ское* (skoi, skaïa, skoïe), used to designate the genders, have been shorn of their final vowels, and the reader will consequently find such expressions as the *Dombrovsk* Mining School, instead of the varying forms, *Dombroffsky, Dombrofsky, Dombrowski, Dombrovsky,* or *Dombrovskaïa* Mining School. However, such proper names as have become fixed with any degree of uniformity in English books have been retained in their familiar dress, although the orthography be erroneous, as Kirghiz for *Kirgiz*, and Ural mountains for *Uralsk* mountains.

In this connection I wish to call attention to the list of errors to be found at the end of this work, and to say, as in the Preface to Manufactures and Trade of Russia of this series of volumes, that this translation has been made in very great haste, and that the typographical work has been done by casemen unfamiliar with the English language, thus making it extremely difficult to avoid errors. In this instance, however, the more important mistakes of this kind, especially such as were apt to be misleading, have been corrected in the table of Errata at the close of the volume.

In presenting this translation of the Mining and Metallurgy of Russia to the visitors of the World's Columbian Exposition at Chicago, I feel confident that the authentic information contained in these pages will be of practical value to those who are interested in the great mining industries of the United States; and it was in this conviction that I accepted the labour of this Edition.

J. M. Crawford.

St. Petersburg, Aug. 11, 1893.

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RUSSIAN WEIGHTS AND MEASURES.

The following tables will serve to define the Russian weights and measures in terms of the French Metric System, as also in those which are used in the United States.

I. Long measure.

The lineal measures of Russia have for a unit the foot, which, according to the laws of Peter the Great, is the same as the English foot.

1 Russian foot	= 1 English or United States foot.
»	= 12 inches = 120 lines = 1,200 points.
»	= 0·304794 metres = 30·4794 centimetres.
1 Russian arshine	= 16 vershocks = 28 inches.
»	= 2⅓ feet = 7/9 or 0·77778 yards = 0·71118 metres.
1 Russian sagene	= 7 feet = 3 arshines.
»	= 2·13356 metres = 213·356 centimetres.
»	= 2·3333 yards.
1 Russian verst	= 500 sagenes = 3,500 feet.
»	= 1066·78 metres = 1·06678 kilometres.
»	= 0·66269 English miles.

II. Square measure.

1 square sagene	= 49 sq. feet = 4·5521 sq. metres.
»	= 5·4444 sq. yards.
1 dessiatine (Russian land measure)	= 2,400 sq. sagenes.
»	= 1·0925 hectars = 2·6997 acres.
1 square verst	= 250,000 sq. sagenes = 104·17 dessiatines.
»	= 1·1380 sq. kilometres.
»	= 0·43916 sq. English mile.

III. Cubic measure.

1 cubic sagene	= 343 cubic feet.
»	= 9·712 cubic metres.
»	= 12·704 cubic yards.

IV. Avoirdupois weight.

1 poud	= 40 Russian pounds = 0·01638 metric tons = 16·380 kilograms.
»	= 0·32243 cwt. or 32·243 Eng. lbs.
1 Russian pound	= 32 lots = 96 zolotniks = weight of 25·019 cubic inches of water at $13^1/_3{}^\circ$ R. in vacuo.
»	= 0·40951 kilograms = 409·51 grams.
»	= 0·90282 English pounds.

Troy weight.

1 zolotnik	= 96 dolee.
»	= 4·2657 grams.
»	= 65·830 grains, Troy.

INTRODUCTION.

THE birth of a true mining and metallurgical industry in Russia and the institution by the Government of systematic measures for its encouragement date only from the seventeenth century. Although before this the beginnings of a metallurgical and salt industry did exist in various parts of European Russia and Siberia, still strictly speaking, metallurgical works, in the present sense of the word, were only first founded in the reign of Peter the Great, who in 1700 also established the first separate official mining administration, known as the "Prikase of Mining Affairs".

At the end of the year 1719 the Mining College was established for the administration of mining affairs and of the artillery. An ukase of Peter the Great dated December 10, 1719, and entitled the "Mining Privilege", forms the first Russian mining law, and the basis of all subsequent governmental measures for the regulation of mines. The Mining Privilege proclaimed an entire freedom in the establishment of a mining industry in Russia, with the right to prospect for ores and all kinds of mineral deposits not only on governmental property and on that of the prospectors, but also on the lands of other proprietors, even without their consent. In case of the appropriation of the property of others for metallurgical works or mines, the owners of the enterprise were obliged to pay the landowner a thirty-secondth part of the profits, besides a special indemnification for the lands occupied by the mines and works, and for the forests required to supply fuel for the furnaces. The workmen employed in mines and metallurgical works were exempted from all taxation and also from military service.

Furthermore, Peter the Great, recognizing the imperial right over all the mineral wealth of the land, instituted a Government tax of one-tenth of the production of all mines. In 1720 he issued ukases to the effect that no one should dare to impede the development of the mining industries, and also authorizing the importation of foreign workmen for employment in Russian works and mines. The most active helpers of Peter the Great in increasing the number of metallurgical works in various parts of Russia, in the Government of Tula, Olonets and the Urals, were Wilhelm de Hennin of Saxony, Tatischev and Nikitin Demidov, a merchant of Tula. De Hennin among other things founded the town of Ekaterinburg and established there the first mining school in Russia.

Even to his death the Great Reformer devoted unceasing and especial care to the development of the mining industry and to the organization of a mining administration in Russia, and thereby gave a firm basis for the growth of this important branch of national wealth. But the elements of mining freedom which were at the basis of the Mining Privilege were not destined to receive that further development for which they were especially intended, nor did they give that impetus to mining matters that might have been assuredly expected had they been properly cultivated. These elements did not remain

in force in Russian legislation for more than sixty years, and during that time the Mining Privilege did not remain without additions and alterations. The Empress Catherine I, by an ukase dated 1727, endeavoured to facilitate the mining industries in distant parts of the Empire, and more especially in Siberia.

In the reign of the Empress Anna Ioanovna the mining administration underwent a further modification, and in 1736 the Mining Privilege was annulled, and a Government Mining Direction was established for the administration of such affairs. On the recommendation of the all-powerful Biron, Baron von Schemberg a native of Saxony was nominated the first director of this office. In 1739 an ukase was issued entitled the Mining Regulations. The most important point in this ukase was the handing over of all the State works, with the exception of Mount Blagodat in the Urals and the copper-mines of Lapland, to the management of private individuals and companies. The iron works on Mount Blagodat were placed under the direction of Schemberg himself. During the administration of the Mining Directorium the works which had been distributed among private individuals fell into a state of the utmost disorder and mismanagement, in consequence of which the Empress Elizabeth Petrovna, in 1742, abolished the Mining Direction, ordered the works to be removed from Schemberg's hands and reestablished the Mining College. The discovery of gold in the neighbourhood of Ekaterinburg in the Berezovsk mines, and the smelting of auriferous silver ores of the Altai mountains at Demidov's works, which from that time passed over to the State, were the most important mining events of the reign of the Empress Elizabeth Petrovna.

The idea of founding a higher mining school in St. Petersburg, which first arose at the close of the reign of the Empress Elizabeth, was only fulfilled during the reign of the Empress Catherine, in 1773. In 1775 the administration of mining affairs in Russia underwent an entire reorganization. Soon after the subdivision of the Empire into governments, it was decreed by an Imperial ukaze, that the mining affairs should be given over to the administration of the local state tribunals by means of special mining commissions. This arrangement brought the metallurgical works of Russia and especially of the Urals into a state of perfect decadence.

In the mining legislation of the Empire the Empress Catherine II took an exactly opposite view from that of Peter the Great in his Act of Privileges. This was brought about by a manifesto dated June 28, 1782, by which the landowners were endowed with a freedom in the disposition of their lands and a right over, not only their superficial area, but also over all the minerals contained beneath, and over the metals produced from such minerals. The main principles of this manifesto remain in force up to the present day. The unsatisfactory management of the metallurgical works of the Empire already called forth certain modifications in the mining administration during the close of the reign of Catherine II, and induced the Emperor Paul, on his accession to the throne, to separate the direction of the mining affairs from the state tribunals, and to re-found the Mining College. The Emperor Paul, on the recommendation of the director of the Mining College, Saymonov, despatched exploring expeditions to various parts of the Empire with a view to the discovery of new mineral deposits and to make a mineralogical survey of the country.

On the formation of the Imperial Ministries by Alexander I, in 1802, the Mining College was subordinated to the Ministry of Finance, and in 1806 it was ultimately abolished and the Mining Department established in its place. In the reign of the Emperor Alexander the name of Derzabin is especially memorable in the administration of min-

ing affairs, as that of the author of a "Project of an Act for the Regulation of Mines", edited July 13, 1806. It was at first proposed to try this project for a period of five years, from 1807 to 1812, and then, after revision, to ultimately confirm it; however owing to the events of those times, it was never revised, but remained in force until the first edition of the code of laws into which it entered in the form of a mines statute. In 1811 the salt industry was also brought under the supervision of the Mining Department. In 1825 the Mining Journal was first published at the instigation of the director Karneev of the Mining Department, under Count Kankrine. This Journal was published with a view to supplying the most recent information concerning mining and metallurgical matters.

During the reign of Emperor Nicolas the mining industry made rapid progress both in its scientific as well as in its technical and administrative aspects. Numerous mining surveys and expeditions were made in various parts of the Russian Empire. And here mention should be made of the expeditions made in 1829, under the special patronage of the Emperor Nicolas, by Alexander von Humbolt and his fellow travellers Gustave Rose and Erenberg, and of the geological survey made by the English savant Murcheson together with the French paleontologist de Vernien and Count Kaiserling. This survey embraced the whole of European Russia and the Urals. Besides these the expedition conducted by Demidov in the south of Russia, with the French savant Le Play at its head, should be mentioned, as also the exploration of the Caucasus and Crimea by Dubois de Monpere, and of the Altai by Chikachev. To this reign also belong the geological researches of the Russian geologists, Schourovsky, Eichwald, Helmerson, Hoffmann and others.

The great reforms made by the Emperor Alexander could not but have their influence on the mining industries. The most important of them, namely, the liberation of the serfs in 1861, brought about a complete revolution in the position of the mining industry of Russia, which in its immediate and possible future consequences must be acknowledged as more important than all the modifications which the Russian Mining legislation had undergone up to that date. The abolition of obligatory serf labour, upon which the entire Russian mining production was, like all other industries, dependent, could not but produce a radical reform in the economic aspect of the industry and in the position of the mining population. With it the responsibilities and duties of the mining administration also inevitably underwent a substantial change. The Government administration having up to 1861 immediately directed the labours of the very considerable number of workmen employed in the state works, and being called upon to guard over the relations held towards the labourers of private works whose proprietors were in their turn more or less the perfect disposers of the labour of their own serfs, was unable to limit itself to purely mining affairs, but was necessarily obliged to take upon itself many of the duties of a general state direction. Thus the mining department had its own police, its court of justice, inspection of schools, hospitals, churches and even its own post. After the liberation of the mining population from obligatory labour, such a union of most varied duties under one administration lost its meaning, and from that time began, so to say, the process of the specialization of the mining administration.

It will be sufficient to cite only the most important of the many measures adopted for the protection of the mining industry during the reign of the Emperor Alexander II. The introduction in 1862 of an excise upon salt led to the withdrawal of the entire and vast salt business of the Empire from the jurisdiction of the Mining Depart-

ment. The Imperial Mints were also separated in 1872, and the abolition of the tax upon crude naphtha led to the inspection of the private naphtha trade being given over to the Mining Direction.

Among the legislative measures of that period mention must be made of the following, having special reference to mining matters:

1. The publication in 1870 of a statute respecting the private gold workings, in which rules were laid down regulating the gold production for the whole Empire: also many other measures respecting the extensive development and encouragement of the gold industry.

2. The declaration of a free naphtha trade and the publication of a special law respecting its production.

3. The giving of special bounties for the encouragement of the preparation of sulphur from pyrites.

4. The abolition of the salt monopoly and the permission of a free production and sale of salt, together with the subsequent introduction of the excise system of the salt revenue in 1862.

5. The publication in 1870 of a new mining law for the governments of Poland on the principle of separating the rights of the landowner from the minerals under his lands.

6. The formation of an Institute of district mining engineers for the inspection of private mines and works.

During the reign of the Emperor Alexander II the mining tributes were one after another subjected to revision, which in general resulted in their being abated, and in some cases abolished. In 1874 the Mining Department was transferred from the Ministry of Finance to the Ministry of State Domains.

Geological surveys and prospectings for mineral deposits were most actively conducted during the reign of the Emperor Alexander II. These surveys embraced every kind of minerals and extended from the frontiers of Germany and Austria over the whole of European and Asiatic Russia, as far as the shores of the Pacific ocean and the adjacent island of Sakhalin, on the one hand, and from the Mourman shores of the Arctic ocean and the mouths of the Petchora to the southern base of the Caucasus and the very heart of central Asia, the unexplored Pamir, on the other. It cannot but be recognized that such explorations must have borne important results both for science and for the development and extension of the mining production of Russia. These explorations, for example, called particular attention to the coal fields, salt and naphtha springs, and also to the iron ores of the south of Russia. Lastly it was during the reign of the Emperor Alexander II that the first meetings of mine owners and metallurgists were held in the various mining centres of Russia for the purpose of discussing the requirements of entire mining districts and of individual branches of the mining and metallurgical industries. Starting from 1881, a series of very important changes were made in the mining administration and legislation of the Empire. The abolition of the excise upon salt and its removal from the control of the Ministry of Finance considerably extended the range of action of the general mining direction. The formation of new mining regulations in western and eastern Siberia and in southern Russia, together with the reorganisation of the existing mining direction of the Urals and Caucasus, increased the powers of the local mining administrations. The relations between the owners on the one hand, and the workmen on the other were regulated by applying the already existing factory law to the private mining and metallurgical industries.

Among the legislative measures of this reign the following should be mentioned as having special reference to mines:

a. The extension of the mining law of 1870 for Poland, by which the expropriation of the subsoil minerals was applied to iron in addition to coal, zinc, and lead ores.

b. The publication of a new law respecting the naphtha industry.

c. The imposition of a tax upon the pig iron and zinc smelted in Poland.

d. The imposition of a tax upon gold with every possible facility for the payment of such a tax.

e. The publication of a law for the preservation of mineral springs.

f. The publication of a special law referring to private mines and works upon free Crown lands. This is a category of lands which plays a very important part in Russia, and for which the Government has never discredited the principle of so-called mining freedom, which Peter the Great placed as the basis of his mining legislation.

The brilliant scientific and practical results attained by the geological surveys of western Europe and the United States induced the Russian Government to found a special geological institute for the purpose of making a systematic geological survey of the Empire. This institute was established in 1882, under the name of the Geological Committee. Its chief aim was the compilation of a general geological map of Russia, together with a systematic description of its formations. The work conducted by the Committee resulted in a substantial modification of the previous geological data for almost all the districts surveyed by them.

Having terminated the historical review of the various changes which the mining administration and legislation underwent from the time of Peter the Great, the present organisation of the mining administration and the mining legislation now in force, may may be discussed.

The direction of the mining affairs of Russia, exclusive of Finland, is mainly concentrated in the Mining Department of the Ministry of State Domains. The only exceptions are the mining and metallurgical industries of the Province of Don Cossacks, which are under the supervision of the Ministry of War, and also the metallurgical works of the Altai and Nerchinsk mining districts of Siberia which are under the management of His Majesty's Cabinet, forming a part of the Ministry of the Imperial Court. It should be remembered that as the mining industries include besides mines the metallurgical works, the mining administration directs not only the raising of ores, but also their mechanical, metallurgical and chemical treatment. The naphtha industry however forms an exception and is subject to the Ministry of Finance.

The Government works and mines are divided into districts, each of which is under the supervision of a special mining inspector. There are four such districts in the Urals, one in northern Russia and one in Poland. The head direction of the Ural districts belongs to the chief inspector of the Government Ural works, who also controls all the private mining industries within these districts. The private works and mines are under the inspection of district engineers, eight in the Urals, four in southern Russia, two in central Russia, three in Poland, one in northern Russia, four in the Caucases, six in western and six in eastern Siberia. The district engineers have an immediate control over the private metallurgical works and mines of their districts and thus form the link between them and the chief mining administration. In certain parts of Russia there are mining directions to which the local district engineers are subordinate. There

are five such directions, one at Ekaterinburg over the Ural districts, one at Ekaterinoslav over the south of Russia, one at Tiflis over the Caucasus, one at Tomsk over western Siberia and one at Irkutsk over eastern Siberia. The district engineers of the two districts of central Russia, of the three districts of Poland and of that of northern Russia, are subordinate to the Mining Department at St. Petersburg. There is a mining direction also in the province of the Don Cossacks. This direction includes a special section for the salt industry and has three district engineers attached to it. The Altai and Nerchinsk mining districts are controlled by mining inspectors who are directly subordinate to His Majesty's Cabinet. There is a special mining direction in Finland.

As regards the mining laws of the Empire, they are published in the seventh volume of the Code of Laws. Many additions and alterations have however been made to this code since its first publication in 1857. Some of these modifications bear a purely local character while others refer to the exploitation of certain minerals. To the first category belong:

a. Rules for the mining industry of the province of the Don Cossacks.
b. Rules for the mining industry of Poland.
c. Rules for private mining enterprises on free state lands.
d. Rules for the coal mines of the island of Sakhalin.
e. Rules for the amber industry on state lands.

To the second category belong:

1. Rules for private gold workings.
2. Rules for the naphtha industry.
3. Rules for the salt industries.

There has been no possibility of publishing a general and systematic mining code because the Government has been and is still making a gradual revision of the original code, since its publication in 1857. In the Grand Duchy of Finland however the original code is still in force.

The following table gives a general view of the production of the mining and metallurgical industries during the reigns of the Emperors Nicholas, Alexander II and Alexander III, that is, from 1825 to 1890.

Years.	Gold.	Silver.	Platinum.	Copper.	Lead.	Zinc.	Pig iron.	Coal.	Salt.	Naphtha.
	P			o			u	d	s.	
1825	237	1,140	11	203,000	—	—	9,644,500	—	—	—
1830	383	1,282	107	236,000	42,400	—	11,169,300	—	20,920,400	—
1835	393	1,212	105	240,200	42,500	153,450	10,501,100	—	22,500,000	—
1840	458	1,205	93	251,600	54,400	167,200	11,331,500	—	26,550,000	—
1845	1,307	1,192	47	254,700	55,900	217,900	11,432,600	—	55,477,000	—
1850	1,454	1,068	10	393,600	41,200	159,100	13,892,300	—	24,829,000	—
1855	1,649	1,100	1	378,600	110,900	67,600	15,310,600	9,494,000	31,559,000	—
1860	1,491	1,070	61	317,100	66,700	112,200	20,467,500	18,309,000	26,232,500	—
1865	1,576	1,084	139	253,000	99,700	188,600	18,280,700	23,331,000	30,638,800	556,900
1870	2,163	868	119	308,400	100,700	230,800	21,949,400	42,416,500	29,013,500	1,704,450
1875	1,996	601	94	222,800	66,000	243,300	26,079,700	104,348,000	35,738,700	8,074,400
1880	2,642	616	180	195,500	70,000	267,800	27,364,400	200,784,000	47,531,900	21,498,000
1885	2,016	687	158	288,250	43,650	279,900	32,205,500	260,577,500	69,180,400	116,258,900
1890	2,403	889	173	349,500	51,100	230,400	56,560,000	367,203,500	84,857,200	242,941,600

Taking the figures giving the production of the most important branches of the mining industry for 1890, their values are found to be as follows:

	Weight.	Value.
	Pouds.	Roubles gold.
Gold	2,155	30,402,900
Silver	1,011	923,400
Platinum	173	692,000
Copper	349,500	2,796,000
Lead	51,100	51,000
Zinc	230,400	553,000
Mercury	17,835	535,000
Tin	800	8,000
Pig Iron	56,560,000	22,624,000
Coal	367,203,500	12,852,200
Salt	84,857,200	3,394,300
Naphtha	242,941,600	9,717,700
Manganese ore	11,139,700	389,900
Sulphur	9,800	5,500

The amounts of gold and silver here given do not agree with those in the preceding table, as the value of these metals are calculated from the quantity of chemically pure metal obtained in 1890, as further explained in the articles on gold and silver. Thus in 1890 the total value of the chief products of the mining industries of Russia amounted to 85,945,200 roubles gold, or 62,491,200 dollars.

The following table, giving the amount and value of the exports and imports of the chief products of the mining industry, shows how far the present production satisfies the internal requirements of the Empire:

Imports.	Weight.	Value.	Exports.	Weight.	Value.
	Pouds.	Roubles gold.		Pouds.	Roubles gold.
Copper and alloys	256,700	2,960,200	Platinum	207	1,115,600
Lead	1,399,900	3,400,500	Copper	5,300	73,200
Zinc	329,800	1,255,000	Lead	3,300	6,200
Mercury	358	12,000	Mercury	13,850	642,900
Tin	161,000	1,653,500	Pig iron	8,200	7,650
Pig iron	8,132,800	5,277,400	Iron and steel	314,700	743,800
Iron and steel	6,790,100	14,671,400	Other metals	7,200	32,900
Coal	94,008,000	10,840,500	Coal	834,700	88,200
Coke	12,292,250	1,614,700	Salt	456,100	75,500
Salt	1,052,300	289,700	Naphtha and products	48,089,300	27,637,000
Naphtha and products	29,400	106,400	Manganese and other ores	8,602,300	3,348,000
Mineral waters	184,100	87,200			
Sulphur	1,153,400	1,028,000			

Hence in 1890 the total value of the imported mining products amounted to more than 43,000,000 roubles, while the value of the exports was 33,750,000 roubles. If the cost of freight be deducted from the value of the imports it will be found that their value equalled that of the exports.

The number of men employed in the mining industries has approximately increased during the last twenty years as follows:

Years.	Total number of workmen.	Years.	Total number of workmen.
1870.	223,400	1885.	349,300
1875.	268,000	1886.	356,300
1880.	283,400	1887.	393,200
1881.	280,400	1888.	419,100
1882.	314,000	1889.	416,900
1883.	323,000	1890.	435,700
1884.	330,750		

During the last five years the number of men occupied in the different branches of the mining and metallurgical industries has varied as follows:

	1886.	1887.	1888.	1889.	1890.
Gold and platinum mines	74,950	85,643	89,215	90,023	87,961
Argentiferous lead.	5,738	4,279	5,532	4,852	4,996
Copper	7,487	9,016	9,812	10,239	11,458
Zinc	1,149	1,220	1,299	577	979
Iron.	197,488	224,737	230,850	216,637	233,654
Mercury	70	206	282	702	687
Coal mines.	33,158	32,781	37,957	43,275	40,571
Manganese mines	1,138	1,318	873	829	3,096
Other metallic mines	—	15	2,392	1,464	496
Sulphur mines and works	250	157	88	35	38
Naphtha industry	3,051	4,102	3,348	4,793	5,994
Asphalt	349	430	452	408	378
Salt	16,194	19,027	14,385	19,607	19,102
Phosphorite clay and quarries. . . .	11,639	11,181	22,012	22,984	21,261

On comparing the figures of this table with those giving the production of the different industries one is struck with the much larger production per man attained in foreign countries. It must however be remembered that in Russia mineral fuel still plays a very insignificant part in metallurgical operations and that the preparation of charcoal occupies the time of a large proportion of the men employed in these industries, and accounts for the disadvantage under which Russia suffers in this respect.

The following table shows the distribution of the workmen according to the different districts and branches of mining industry for the year 1890:

Classes of Industry.	Urals.	Central Russia.	Poland.	S. and S.W. Russia.	Caucasus.	Trans-Caspian and Turkestan.	N. Russia.	W. Siberia.	E. Siberia.	Finland.	Total.
Gold workings	44,086	—	—	—	—	—	—	9,512	28,242	268	82,108
Platinum workings	5,853	—	—	—	—	—	—	—	—	—	5,853
Argentiferous lead mines	20	—	—	—	186	—	—	2,356	410	—	2,972
» » works	—	—	—	—	110	—	—	1,864	50	—	2,024
Copper mines	2,532	—	—	—	1,292	—	28	103	—	120	4,075
» works	4,742	—	49	—	1,668	—	107	182	—	635	7,383
Zinc mines	—	—	419	—	—	—	—	—	—	—	419
» works	—	—	560	—	—	—	—	—	—	—	560
Mint	—	—	—	—	—	—	324	—	—	—	324
Iron mines	22,816	3,597	3,935	2,146	10	—	—	176	51	46	32,777
» works	142,241	22,157	7,441	13,552	—	—	10,652	454	1,249	3,131	200,877
Coal mines	2,426	2,452	8,692	25,195	370	162	4	757	513	—	40,571
Manganese mines	47	—	—	482	2,567	—	—	—	—	—	3,096
Cobalt, chromiron and other mines	370	—	—	—	38	—	—	88	—	—	496
Sulphur mines and works	—	—	—	—	35	3	—	—	—	—	38
Naphtha industry	—	—	—	70	5,886	3	—	—	—	—	5,959
Kerosene works	—	949	—	20	3,248	—	292	—	—	—	4,509
Asphalt works and beds	—	291	—	—	60	27	—	—	—	—	378
Salt: rock	410	—	—	503	257	—	—	—	—	—	1,170
Salt: self deposited	136	—	—	11,030	347	—	—	2,377	74	—	13,964
Salt: evaporated	2,907	—	45	388	5	—	173	—	355	—	3,873
Phosphorite	—	60	—	104	—	—	—	—	—	—	164
Glauber salt	45	—	—	—	16	—	—	34	—	—	95
China clay	—	—	—	760	—	—	—	—	—	—	760
Stone quarries	1,060	100	1,131	12,699	1,440	—	—	13	—	—	16,443
Fire clay and bricks	2,083	156	174	1,344	68	—	35	198	—	—	4,058
Mercury mines and works	—	—	—	687	—	—	—	—	—	—	687
Total	231,774	29,762	22,446	68,980	17,603	195	11,615	18,114	30,944	4,200	435,633

The province of Turgaisk is adjoined to the Urals, and the Kirghiz steppes to western Siberia. In the Urals, central Russia and Poland, where the mining industry has long taken root, local workmen are chiefly employed. This however is not the case in southern and northern Russia nor in Siberia, where in only a comparatively small number of cases has a purely mining population begun to settle around the mining centres. This economical importance of the mining industries to the state is to a certain extent revealed in the following table, giving the revenue acquired in the form of dues and other tributes collected from private mining and metallurgical enterprises:

Years.	Gold and platinum.	Pig iron.	Copper and other metals.	Salt.	Naphtha and its products.
	R o u b l e s.				
1855	3,231,700	769,700	769,700	9,133,600	—
1860	2,069,800	446,900	300,200	8,212,900	—
1865	2,001,000	423,850	336,000	10,785,500	—
1870	2,740,800	412,600	46,000	11,956,800	—
1875	1,972,200	349,900	87,100	11,283,500	—
1880	712,100	307,100	47,200	15,598,300	—
1885	2,368,000	426,500	173,300	645,200	—
1890	3,375,600	573,700	157,000	474,000	10,658,000

The causes influencing the fluctuations shown in the above table will be explained in speaking of the separate industries.

Mining Schools and Institutes.

In Russia a higher mining education is given at the Institute of Mines at St. Petersburg, while a more elementary is obtained at the Ural, Barnaoulsk and Dombrovsk mining schools, at the Lisichansk Overmen's School and at Poliakov's Mining School. Al these educational establishments with the exception of the Barnaoulsk school are under the supervision of the Ministry of State Domains. The Barnaoulsk School, being situated in the Altai mining district, is under the control of His Majesty's Cabinet. Besides which the Ministry of Public Instruction has recently organized lower and middle class technical schools throughout the Empire. These schools give instruction in mining among other subjects. At the present time the Ministry has two such schools under its supervision within the limits of the Ural mining districts.

The Mining Institute was founded by the Empress Catherine II by an ukase dated October 21, 1773, at the request of the owners of the Bashkir gold mine for the purpose of supplying competent engineers to direct the mines and metallurgical works of the Empire. Up to 1865 it was known as the Mining Cadet Corps, and was organized after the pattern of military shools. It bore a brilliant reputation not only for the competent mining engineers which it turned out, but also for the general education which it gave, and a long list could be made of the distinguished statesmen and men of every profession who received their education at the Mining Cadet Corps. In 1866 the

Mining Institute was reorganized and its character completely changed. It was converted into a civil establishment and higher school for purely mining matters. The course of study covers five years. The Mining Institute receives a yearly Government grant of 138,000 roubles, 16,000 of which go to scholarships and 12,700 for special assistance of the students. At the present time there are three hundred students in the Mining Institute. The Institute possesses a library, chemical laboratory and museum, which is famous for its collection of minerals; its paleontological and geological collections are also very extensive.

The Ural Mining School, situated in the town of Ekaterinburg, and the Barnaoulsk School in the town of Barnaoul, were founded at the very birth of the mining industry in the Urals and Altai, the Ural school being founded in 1721 and the Barnaoulsk in 1779. The Lisichansk Overmen's School and Poliakov's Mining School are situated in the neighbourhood of the Donets coal fields, the former having been founded in 1873 and the latter in 1877. The Dombrovsk Mining School was opened in 1889 in the centre of the Polish mining district, that is, in the village of Dombrov. All these schools have the object of preparing the under-staff of mines and works. The Lesichansk and Poliakov's schools are exclusively mining schools, while the others are also technical and metallurgical. The Lisichansk Overmen's School and the Ural and Dombrovsk mining schools receive a yearly government grant of 57,000 roubles. The yearly expenses of the Barnaoulsk School amount to about 23,000 roubles which falls upon His Majesty's Cabinet; Poliakov's School costs its founder about 20,000 roubles a year. In the year ending 1892 these four schools had a complement of 680 students. In conclusion it should be mentioned that the Government purposes to found a new mining shool at Irkutsk for the object of preparing mining engineers for the gold workings of Siberia.

Gold.

The production of gold in Russia dates from the middle of the eighteenth century, when deposits of this metal were almost simultaneously discovered in the Urals and in the government of Archangel. In the Urals gold was quite accidentally discovered in 1744 on the spot where the Beresovsk gold mines were subsequently situated, near the town of Ekaterinburg. These mines began working in 1748. Only ten years after their opening the production of these mines attained one poud of metal per year, while during the years 1803 to 1810 they gave as much as twenty-two pouds per year. From 1814 however the output began to decrease gradually, owing to the impoverishment of the gold-bearing veins as the depth of working increased.

In the government of Archangel gold was first discovered in 1745 in the Kemsk district at the Voitzk copper mine where particles of gold of various sizes were found disseminated in a variagated copper ore. After being intermittently worked this mine was ultimately closed in 1794, after giving a total output of three pouds and thirty-two and three-fourths pounds of gold. At the same time as the discoveries in the Urals and government of Archangel, gold was also obtained, in 1745, from the silver smelted from the ores of the Smeinogorsk mine in the Altai. In 1812 the gold industry and especially the exploitation of gold-vein deposits, was opened to all Russian subjects. Private individuals were only allowed to work gold-bearing sands in 1819.

The first discovery of alluvial gold was made in 1814 at the above-mentioned Beresovsk mines. In Siberia alluvial gold was first discovered in 1829 on the eastern side of the Alataou mountains, dividing the systems of the Yenisei and Tomi. In 1840 and 1841 rich alluvial deposits were found both in the southern and northern systems of Yenisei district. The richness of these deposits is clearly shown by the fact that in 1847 the Yenisei district alone gave more than 1,200 pouds of gold. From this time the discovery of alluvial gold gradually extended over Siberia and the gold mines acquired more and more localities, extending further and further east and at last reaching to the most eastern limits of Siberia. *

The general character of the Russian gold deposits is as follows:

1. In the Orenburg region small gold workings mainly predominate, and the greater part of them are worked by small parties of miners. The deposits have neither the thickness nor the considerable extension which distinguishes the Siberian deposits. The majority of them are not situated in the valleys of rivers, but on plains, on the summits or declivities of mountains, forming separate independent but small and irregular beds, of gold. An exception is presented at the Miassk workings where at the present time a considerable industry has been established.

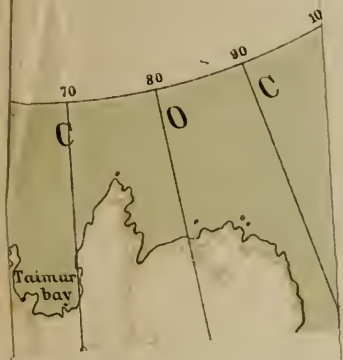
2. The deposits of the government of Perm are also distinguished for their poorness and variableness, and are of inconsiderable size. Those of the Bogoslovsk region are the least variable in their production. The deposits here sometimes extend over several versts and somewhat recall those of eastern Siberia.

3. The deposits of the Altai mountains differ sharply in their internal character from the alluvial beds deposited from the Sayansk and Yablonov mountains of Eastern Siberia along the river systems of the Yenisei, Lena and Amour with their tributaries. The Altai deposits are not rich, are narrow in their extension, not thick and have an unequal and faulty stratification. Those of the Tomsk district are particularly poor. Those of the Achinsk and Minousinsk districts are richer than those of the Tomsk, but still are poor. In general the gold deposits of western Siberia are poor and it is not rare to find workings where it is impossible to place more than ten or fifteen men, and that without horses.

4. The gold workings of the Yenisei which were formerly distinguished for their considerable richness, continuity and unvariableness have, with the working out of the richer deposits, gradually changed their character and become of a kind necessitating their being worked by small enterprises. In general this kind of exploitation is becoming more and more frequent in this district.

5. The deposits of the Nerchinsk district, Amour region and Yakutsk province, are distinguished for their richness, continuity and considerable extension, In these parts large enterprises predominate and there are all the conditions for their success. In the Vitimks and Alekminsk regions some of the deposits are exploited by underground workings. In general the richness of the gold deposits of the rivers Lena, Amour and their tributaries, shows itself in every respect, beginning with their width, size of stratification and the amount of gold they contain. Instead of five to seven sagenes which form the width of the poorer systems, the deposits of eastern Siberia are a hundred to two hundred sagenes wide and more. They are four to six feet thick and are very

* See the accompanying map of the gold and silver-bearing districts.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Cartographical works A Ilyne S.P.B.

uniform in their formation, without any faults. The average contents of gold in the sands are from two to three zolotniks and frequently more, while the poorer deposits of other districts do not contain more than twenty to thirty dolia. Thus the yearly production of gold from the workings of such deposits attains fifty to a hundred pouds, a figure which is impossible for the poorer districts. It is evident that the modus of working the richer and poorer deposits must vary considerably.

There exist data for the production of gold beginning with the year 1814. During the first two years thirty pouds and twelve and one-half pounds of gold were produced. The following table reviews the further production. In this table the production of gold is grouped in periods of five years and the mean yearly amount is given.

Years.	Production of gold.		Average yearly production.		Years.	Production of gold.		Average yearly production.	
	Pouds.	Pounds.	Pouds.	Pounds.		Pouds.	Pounds.	Pouds.	Pounds.
1816—1820	84	19·25	16	36	1856—1860*	8,129	37·75	1,625	39·5
1821—1825	630	17	126	3·4	1861—1865	7,350	17·25	1,470	3·5
1826—1830	1,476	10·25	295	10	1866—1870	9,211	39	1,842	15·8
1831—1835	2,032	30	406	22	1871—1875	10,758	1·2	2,151	22·2
1836—1840	2,295	22	459	4·4	1876—1880	12,401	33	2,480	14·6
1841—1845	5,384	1	1,076	32·2	1881—1885	10,827	25·25	2,165	21
1846—1850	8,094	19	1,618	35·8	1886—1890	10,994	38	2,198	39·6
1851—1855	7,550	10	1,510	2					

Altogether from 1814 to 1890 inclusive there were produced 97,253 pouds of gold, not counting that which was obtained from silver. It will be seen from the above table that up to 1850 the production of gold steadily increased, while during the subsequent thirty years the output was subject to various fluctuations. A maximum was reached in 1880 when the production was 2,641 pouds and 28·75 pounds. During the last decade, after falling to 2015·5 pouds in 1885, the production has again revived and is slowly increasing from year to year. The following table gives the participation of the different regions in the general production:

Years.	Urals.	W. Siberia.	E. Siberia.
	Per cent.		
1861—1865 . . .	21·3	4·6	74·1
1866—1870. . . .	21·7	6·1	72·2
1871—1875. . . .	17·2	7·2	75·5
1876—1880. . . .	20·0	6·0	74·0
1881—1885. . . .	22·6	6·1	71·2
1886—1890. . . .	28·7	7·0	64·2

A more detailed review of the production of gold during the last ten years is given in the next table. These figures represent the amount of gold dust as received from the gold washers. They give an idea of the relative importance of the different gold-producing regions during recent years, but they do not permit of making deductions res-

* Until 1860 are given the product of alloy gold, and since that date the official figures include only schlich gold.

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* Until 1860 are given the product of alloy gold, and since that date the official figures include only schlich gold.

pecting the impoverishment or exhaustion of any of the districts. To do this it is necessary on the one hand to review the position of the gold industry for a longer period of time, and on the other hand, to subject less extensive areas, in which the general character of the deposits and conditions of their working are more uniform, to a separate investigation.

Years.	Urals.		W. Siberia.		E. Siberia.		Finland.		Total yield of gold.	
	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.
1881	486	38¼	135	16¼	1,620	21½	1	9¼	2,244	5¼
1882	456	22	126	30¼	1,622	31	1	6¾	2,207	10
1883	493	11½	134	6	1,554	12	—	24¾	2,182	14½
1884	486	17	131	7	1,561	25½	—	—	2,178	12¾
1885	530	38	134	36¾	1,349	13	—	15	2,015	22¾
1886	560	8	136	22¾	1,345	1	—	11¾	2,042	4
1887	649	30¼	149	28	1,328	6½	—	16½	2,128	2¼
1888	665	26	154	6¼	1,326	1¾	—	33	2,146	27
1889	641	15½	169	19¼	1,462	9¼	1	15¾	2,274	19¾
1890	642	21½	160	39¾	1,599	—¼	1	3½	2,403	25

Without entering upon this subject more fully, it may be pointed out that a greater or less yield of gold in individual districts and in different years, is dependent upon such a mass of most varied facts, as is rarely met with in any other branch of industry. In the first place the gold industry is considerably influenced by legislative measures and their frequent modifications, and especially by the collection of dues upon the yield of gold, and to this fact may be ascribed some of the most decisive fluctuations in the production of this metal. On the other hand the various forces of nature play an exceedingly important part in the gold industry. The most essential element in the extraction of nearly the entire production of gold by the washing of gold-bearing sands, is water. A dry summer and a scarcity of water are very injurious, while an excessive amount of water, especially if it appears suddenly, frequently bursts the reservoirs and sluices and produces a perfect drought. It often happens that in course of one summer there is a scarcity of water followed by too great an abundance. But the injury produced by a dry, hot summer with its scarcity of water, is compensated by its utility in thawing the peat soil which covers the gold-bearing deposits, for in those localities where the gold industry is most developed, the entire soil is frozen, and it is necessary to thaw it before the gold-bearing sand can be washed. Besides these meteorological phenomena having a direct influence on the operations of the gold workings, the price of bread also has a most important effect, and which at the gold workings is entirely dependent upon the harvest of the preceding years and determines the cost of labour, which in some localities reaches 900 to 1,400 roubles per man for a working year, and which sometimes only covers four or five months.

But one of the most, if not the most important factor in the yield of gold, is the exchange value of the paper rouble. As by law the gold mine owners are obliged to hand over all the gold extracted by them to the Government, which returns it to them in the form of gold coin. As all their accounts are estimated in paper roubles, it is clear that a very important part must be played by the relative values of the metallic and

the paper rouble. The lower the exchange the more desirable is it to extract the greatest possible amount of gold and it often happens that the gold-mine owners make their profits on the exchange alone. Moreover this, the most important factor in the gold industry, cannot be in any way foretold and therefore strongly reflects itself upon the yield of metal. It will be readily understood from this enumeration of the most important factors influencing the gold industry, that a series of bare figures giving the production might lead to an entirely erroneous conclusion.

The total yield of gold in Russia includes comparatively only a very small quantity of gold extracted from auriferous rock. Since 1882, however, the amount produced from auriferous veins has gradually risen as is seen from the following table:

Years.	Yield of veinous gold.					
	Urals.		Siberia.		Total.	
	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.
1882	60	20¼	9	24½	70	4¾
1883	77	14½	9	20¾	86	35¼
1884	71	11¼	19	38¼	91	9½
1885	91	8	18	36½	110	4½
1886	101	9¼	33	15½	134	24¾
1887	130	13	33	13	163	26
1888	148	22½	23	18¾	172	1¼
1889	146	16¾	25	29¼	172	6
1890	153	4¾	23	36¾	177	1½

The above table shows that the extraction of veinous gold progresses much more rapidly in the Urals than in Siberia, where the working of auriferous veins is carried on in both portions of the Yenisei district and in the district of Nerchinsk. It is interesting to follow the total number of gold workings under exploitation and the amount of sand and quartz washed by them during the last ten years.

Years.	Urals.		W. Siberia.		E. Siberia.		Total.	
	№ of workings.	Sand and quartz washed, in pouds.	№ of workings.	Sand and quartz washed, in pouds.	№ of workings.	Sand and quarts washed, in pouds.	№ of workings.	Sand and quartz washed, in pouds.
1881	643	324,972,000	147	141,917,000	516	710,756,000	1,306	1,177,645,000
1882	455	307,062,000	159	155,424,000	487	663,386,000	1,101	1,125,871,000
1883	513	319,452,000	165	151,516,000	501	695,132,000	1,179	1,166,100,000
1884	613	347,450,000	189	153,466,000	504	699,158,000	1,306	1,200,075,000
1885	616	381,711,000	209	147,203,000	534	635,179,000	1,362	1,164,093,000
1886	689	444,176,000	215	151,216,000	541	643,469,000	1,445	1,238,961,000
1887	852	515,563,000	248	176,659,000	580	656,869,000	1,680	1,349,091,000
1888	952	538,255,000	252	179,315,000	585	630,868,000	1,789	1,348,438,000
1889	912	516,075,000	262	194,187,000	630	652,993,000	1,804	1,363,255,000
1890	797	471,691,000	248	184,496,000	671	735,259,000	1,716	1,385,447,000

The amount of sand washed is in intimate relation to the number of labourers occupied in the mines. The following table gives the number of men employed in the gold mines of different districts.

Years.	Number of men employed.			
	Urals.	W. Siberia.	E. Siberia.	Total.
1881	35,741	6,400	39,681	82,102
1882	31,651	6,653	26,768	65,072
1883	40,241	7,148	26,252	73,641
1884	40,930	8,094	27,441	76,465
1885	39,594	8,624	27,442	75,312
1886	38,794	9,158	25,593	73,546
1887	46,339	11,616	23,203	82,158
1888	47,842	11,460	24,803	84,105
1889	47,066	10,585	26,697	84,348
1890	44,086	9,512	28,242	81,840

The private gold-mine owner is obliged to forward all the gold extracted by him to the nearest State smelting houses; the gold is sent by him in the form of dust. There are three such smelting houses in the Russian Empire, one at Ekaterinburg for the Ural district, one at Tomsk for western Siberia, and one at Irkutsk for eastern Siberia. Besides which His Majesty's Cabinet under whose direction are the works of the Altai and Nerchinsk districts, has its own laboratories and smelting houses, where the unrefined gold is smelted and assays taken for determining the amount of chemically pure gold it contains. Besides gold dust these laboratories also treat the silver smelted in the Empire and separate the gold it contains.

The following table gives the amounts of chemically pure gold extracted during recent years from unrefined gold and from silver:

Years.	From gold dust.				From silver.				Total.			
	Pouds.	Lbs.	Zolotniks.	dollies.	Pouds.	Lbs.	Zolotniks.	dollies.	Pouds.	Lbs.	Zolotniks.	dollies.
1883	1,838	17	42	55	9	26	57	94	1,848	4	4	52
1884	1,864	26	17	52	14	4	63	7	1,878	30	80	59
1885	1,704	1	3	77	13	30	53	62	1,717	31	57	43
1886	1,702	37	1	14	17	—	17	74	1,719	37	18	88
1887	1,881	13	95	80	16	20	52	21	1,897	34	52	5
1888	1,907	11	55	12	15	9	53	53	1,922	21	12	75
1889	2,007	27	2	25	14	36	38	6	2,022	23	40	31
1890	2,140	11	—	47	15	15	62	28	2,155	26	62	75

The legislative measures introduced by the Russian Government for the private gold industry, have been frequently modified as the development of the industry has progressed. Up to the commencement of the present century the exploitation of gold formed a Government monopoly. In 1812 private individuals were first allowed to prospect for gold in the Urals on their own property. In 1826 Count Kankrine, the Minister of

Finance, asked the Emperor Nicholas I to grant certain private individuals special privileges for prospecting for gold on the Crown lands of the governments of Viatka and Tobolsk. Similar privileges were afterwards granted to various individuals throughout the whole of Siberia so that in 1838 when the first private gold-mining statute was edited, there were already as many as two hundred persons occupied in the gold industry. Owing to the progress made in the gold industry the statute of 1838 was revised in 1851. And lastly in 1870 new regulations for the private gold industry were published. In these regulations the previously existing diverse rules for different localities were changed for a general regulation act for the gold mines of the whole Empire. During the last twenty-two years some essential modifications have been also made in this act.

The chief conditions governing the exploitation of gold are now as follows: in granting the landowners or persons nominated by him perfect freedom in the prospecting and exploitation of gold-bearing sands and ores, and requiring only that the exploitation should be carried on without injury to the health, or danger to the lives of the workmen, the law demands the payment of a definite tribute to the State upon the gold extracted and the fulfillment of certain formalities in the exploitation of gold on State lands, and the properties appertaining to His Majesty's Cabinet. These gold-bearing deposits and veins on the State lands and the properties appertaining to His Majesty's Cabinet are let to private individuals for their temporaly exploitation until they become exhausted; that is to say, the gold-bearing deposit is regarded as movable property. The exploitation of gold is permitted to all persons possessing civil rights, both Russians and foreigners, with the exception ot Jews. All persons desirous of working gold deposits or veins are obliged to obtain a permissary certificate from the mining administration. Any locality which is not under exploitation, and which has not been previously claimed, is free for prospecting, and the gold deposits on it may be occupied under preliminary surveys over an area of not more than five versts along the direction of the valley or stream, and over the whole breadth of the same.

In the case of gold-bearing veins the area is limited to one verst radius from the gold miner's claim, marked by a post. Should the gold miner ultimately wish to exploit the claim, he is obliged to make a declaration of the gold deposit, or vein, before the police direction of the district in which it is situated. This declaration gives the right of legally acquiring the claim. To each working there is allotted a locality designated in the declaration. This allotment extends from a definite starting point, and always in the opposite direction to the current of the stream. For ore deposits the area of the allotment is limited to one square verst the width not being less than one-third of the length, while for alluvial deposits the working area must not exceed five versts and in European Russia the whole area must not exceed one square verst. The methods of working are left to the judgment of the gold miner, but the extraction of gold both in open and underground workings must be conducted without injury to the health or danger to the lives of the workmen.

There are special rules regulating the use of water on the gold workings and its consumption on neighbouring enterprises. The gold miner extracting gold on private lands pays a tribute to the Government on the yield of metal, while those working on State lands or on property belonging to His Majesty's Cabinet also pay a rental for the locality occupied by them. The tribute on the yield of gold is levied on the amount of pure gold and silver contained in the unrefined metal. In the Olekmin district, as

the richest, the tax amounts to ten per cent, a rental of ten roubles per dessiatine for the workings on State lands; in the provinces of the Amour the tax is five per cent, and the rental five roubles per dessiatine, while in the remaining parts of Siberia and in European Russia the tax is three per cent, and the rental one rouble per dessiatine.

The gold workings on the lands appertaining to His Majesty's Cabinet are divided into three categories according to their richness, and pay a tribute to the Cabinet to the extent of from five to fifteen per cent, and a rental of fifteen kopecks per sagene on the length of the workings. Besides this the gold miner has to pay the expense of transporting the gold from the State smelting house at Ekaterinburg, Tomsk, or Irkutsk to the Imperial Mint at St. Petersburg, and the cost of converting the gold into coin. The gold and silver having been smelted and assayed, the proprietor receives bills of credit for the amount of pure metal supplied by him. These bills of credit are payable in gold and silver coin or in ingots, and may be used as a means of exchange between private individuals and banks, and are accepted in payment at the customhouse. Besides which the Siberian gold mine owners are able to obtain advances on their gold dust at the Tomsk, Yenesei and Irkutsk branches of the State Bank, to the amount of two roubles per zolotnik. This is a great help to the gold-mine owners who are frequently in want of capital.

In concluding this short review of the legislation of the private gold industry, it is necessary to add that the Government, recognizing the great importance of the treatment of gold-bearing ores, tailings and residues by chemical processes, has recently permitted the construction of such works on the basis of the special rules regulating the treatment of the tailings and washings of gold workings.

Platinum.

Platinum occurs in the Urals in the government of Perm * where it is found on various private properties and state lands. In the mining district of Goroblagodat there are seventy allotments for the exploitation of platinum under different private individuals. The platinum occurs in the form of alluvial deposits or platinum-bearing sands, which frequently also contain gold. These deposits vary in richness, from several doley to four or five zolotniks and more in a hundred pouds of sand. The thickness of the platinum-bearing deposits is rarely less than three, and sometimes reaches seven feet. The grains of platinum are small in size, but sometimes small nuggets are found weighing one or more kilograms. The platinum is often accompanied by other rare metals such as iridium and osmium. The Ural platinum deposits are the only ones in the world, as platinum is worked nowhere else, and is only known as a mineral finely disseminated in certain rocks. At the present time all the platinum extracted in the Urals is forwarded in the crude state to St. Petersburg whence it is sent abroad. Although there are two laboratories in St. Petersburg for refining platinum ore, still the greater quantity is sent abroad in the crude state. The production of platinum is subject to a tax of three per cent for leasehold, and four per cent for freehold works. The yearly revenue thus brought to the Government equals from sixty to eighty thousand credit roubles.

The rapid and variable fluctuations in the price of a product having no definitely fixed exchange value, but indispensable to the arts, reflects itself upon the production

* See map of the districts of production of precious metals.

of platinum in Russia. Thus when the price of the metal is high it becomes profitable to work the poorer deposits, while it is only possible to work the very richest when the price is low.

Although the first deposits of platinum in Russia were discovered in 1819, still the actual exploitation of this metal began only in 1824 when rich veins were discovered in the Nizhni-Tagilsk district of Demidov's works.

From 1828 to 1845 platinum money was coined in Russia. The denomination of these coins was three, six and twelve roubles; the total value of the platinum money put into circulation was 4,250,000 roubles. During this period the production of platinum increased considerably, but when platinum coinage was stopped the exploitation of the metal almost entirely ceased and only revived in 1859. From that time the production has varied with the foreign demand and market price. The production of platinum began in 1824 with 2 pouds 1 pound; in 1825 it increased to 11 pouds 24·5 pounds, and it subsequently varied in the manner shown in the following table, in which the data are given for periods of five years.

	Production.		Average yearly production.			Production.		Average yearly production.	
	Pouds.	Lbs.	Pouds.	Lbs.		Pouds.	Lbs.	Pouds.	Lbs.
1826—1830	319	26¼	63	37¼	1861—1865	441	18	88	11⅗
1831—1835	550	34	110	6⅘	1866—1870	599	34¼	119	38⅘
1836—1840	452	7½	90	17½	1871—1875	531	23¼	106	12⅕
1841—1845	590	27¼	118	5½	1876—1880	646	4	129	8⅘
1846—1850	23	17¾	4	27½	1881—1885	942	6	188	17⅕
1851—1855	91	12	18	10⅖	1886—1890	1033	6	206	25⅕
1856—1860	136	33	27	14⅗					

Thus the total production of crude platinum in Russia from 1824 to 1890 inclusive was 6,373 pouds. In giving in the following table the number of platinum deposits under exploitation during recent years, together with the quantity of sand washed and the production of metal, it should be noted that a portion of the platinum was obtained as a by-product from gold.

Year.	Number of working deposits.	Sand-washed.	Production of metal.	
		Pouds.	Pouds.	Lbs.
1881	66	15,036,900	182	10¼
1882	82	20,127,800	249	12
1883	107	11,194,000	215	33
1884	71	19,502,000	136	25
1885	58	17,388,400	158	8½
1886	83	23,036,100	263	21¾
1887	93	61,773,300 *	269	4
1888	75	58,856,700	165	35¼
1889	72	67,184,800	160	36½
1890	82	47,334,100	173	26¾

* Previous to 1887 there were no official returns of the amount of sand washed; up to that date the platinum-bearing was given together with the gold-bearing sand.

*

The largest quantity of platinum is now extracted at the deposits of Nizhni-Tagilsk belonging to Prince Demidov San Donato, and at the Krestovozdvighensk deposits of Count Shuvalov. In 1890 there were 5,853 men actually employed in the exploitation of platinum. The export of platinum is given in the following table:

Year.	Germany.	Great Britain.	Austria.	Total.
	P	o u	d	s.
1884 . . .	103	28	—	131
1885 . . .	28	261	1	290
1886 . . .	52	237	—	289
1887 . . .	50	263	—	313
1888 . . .	51	178	—	229
1889 . . .	34	216	—	250
1890 . . .	13	194	—	207

The value of the yearly export of platinum from Russia amounts to from 1,000,000 to 1,560,000 roubles.

Silver.

Although the first discovery of silver ores in the district of Nerchinsk in eastern Siberia was made in the beginning of the second half of the seventeenth century, still the actual smelting of silver was not begun before 1704. And veins of silver ore were discovered at Smiainogorsk in the Altai by Akinfi Demidov in 1735, but it was only after ten years, in 1745, when they were taken over by the Government, that the smelting of the ores was begun. The production of silver at the Nerchinsk works attained a maximum during the seventies of the last century, when it amounted to 600 pouds; during the same period the production of the Altai works exceeded 1,100 pouds, so that at that time the works of these two districts produced as much as 1,700 pouds of silver. The following data show how much the production of silver has varied since the beginning of the present century.

	Production.		Average yearly production.			Production.		Average yearly production.	
	Pouds.	Lbs.	Pouds.	Lbs.		Pouds.	Lbs.	Pouds.	Lbs.
1822—1825	4,540	—	1,135	—	1856—1860	5,306	2	1,061	$8^{2}/_{5}$
1826—1830	5,780	—	1,156	—	1861—1865	5,259	31	1,051	$38^{1}/_{5}$
1831—1835	6,361	8	1,272	$9^{3}/_{5}$	1866—1870	4,972	$17^{3}/_{4}$	994	$19^{1}/_{2}$
1836—1840	6,053	6	1,210	$25^{1}/_{5}$	1871—1875	3,509	—	701	32
1841—1845	5,980	33	1,198	$6^{3}/_{5}$	1876—1880	3,378	2	675	$24^{2}/_{5}$
1846—1850	5,690	32	1,138	$6^{2}/_{5}$	1881—1885	2,731	1	546	$8^{1}/_{5}$
1851—1855	5,236	33	1,047	$15^{4}/_{5}$	1886—1890	4,408	$30^{1}/_{4}$	881	30

During the present century the production of silver was greatest in 1831, but even then it was only 1,318 pouds or not more than 76 per cent of the yield at the close of the last century. The following table shows the yield of silver for the different silver-bearing districts during the last ten years *.

* See map of the districts of precious metals.

Year.	Caucasus.		Altai.		Kirghis steppes.		Nerchinsk.		Urals.		Finland.		Total.	
	Pouds.	Lbs.	Pouds.	Lbs.	Pouds	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.
1881	29	32¼	463	4½	—	—	54	39	28	4¼	—	—	576	—
1882	35	14	397	25¼	—	—	49	37¾	6	32	—	—	489	29
1883	30	15½	368	12¼	—	32¼	50	20½	—	13	—	—	450	13¼
1884	29	27	446	29¼	—	—	51	6¾	—	—	—	—	527	23¼
1885	33	36¾	535	23½	35	2¼	52	13	—	—	30	20	687	15½
1886	30	30½	613	6¾	84	23½	52	39½	—	—	28	30	810	10¼
1887	32	17¼	661	38	171	16¼	51	25	—	—	21	17¾	938	34¼
1888	29	8¼	682	4½	136	8	50	30	—	—	25	35½	924	6¼
1889	33	32	652	1¾	110	10½	50	4	—	—	—	—	846	8¼
1890	30	24½	681	8	72	28½	54	34¼	—	—	49	36	889	11¼

The Altai mining district of His Majesty's Cabinet continues to supply more than three-fourths of the entire production of silver in Russia. In 1860 the Altai district yielded 1,060 pouds; but twenty-five years later the production fell to less than a quarter of that amount, that is, only 446·75 pouds were smelted in 1884; since then the production has revived and has gone up to 681 pouds. In the Nerchinsk mining district of His Majesty's Cabinet, where up to 1863 the production of silver did not exceed 7·5 pouds, the yield has steadily risen since 1866, and in 1881 it attained 55 pouds at which figure it also stands in 1890. In the Caucasus there is a single silver smelting establishment, the Alagirsk works, belonging to the State. The annual production of these works varies between twenty-nine and thirty-five pouds. The works of the Kirghis steppes are very primitive and their production varies considerably. In the Urals, where silver was first smelted in 1874, the production reached a maximum of 28 pouds, 35 pounds in 1880, but it subsequently fell rapidly and ceased entirely in 1884. Lastly in Finland there is also one establishment, the Pitkaranda works on the northern shores of Lake Ladoga which has recently given from 22 to 50 pouds of silver yearly.

All the silver smelted in Russia is extracted from argentiferous lead ores; but besides this all the gold produced in Russia contains silver, whose amount is determined by assays taken at the state smelting houses.

Although the amount of chemically pure silver contained in the crude silver ingots can only be determined by assays taken at the smelting works, and the necessary data for this are wanting for certain years, still the following table gives the minimum amount of chemically pure silver contained in the silver ingots and gold produced in Russia during the last eight years.

Year.	In silver ingots.		In unrefined gold ingots.		Total.	
	Pouds.	Lbs.	Pouds.	Lbs.	Pouds.	Lbs.
1883	411	39	179	31	591	30
1884	527	23	229	10	756	33
1885	537	8	146	9	683	17
1886	762	24	151	7½	913	31½
1887	876	31½	166	7½	1,042	39
1888	823	22	171	—	994	22
1889	773	—	179	8	952	8
1890	826	13	185	25¾	1,011	28¾

The silver smelted by private individuals is subject to a tax which was lowered in 1887 from ten and fifteen per cent to three per cent for freehold, and four and a half per cent for leasehold works. It may not be superfluous to supplement the above remarks upon the production of precious metals in Russia, by a table giving the amount of money coined in the Empire during the last ten years.

Year.	Roubles.			
	Gold.	Silver bank money.	Silver exchange money.	Copper.
1881	22,735,072	435,021	1,112,516	648,951
1882	27,187,040	504,854	1,500,003	481,150
1883	25,119,054	556,311	1,000,004	299,852
1884	26,802,088	425,519	1,000,006	100,000
1885	18,126,210	564,091	1,200,053	100,000
1886	27,055,175	510,551	1,000,002	100,000
1887	25,510,095	500,022	1,000,011	100,000
1888	24,430,030	1,753	2,000,001	100,000
1889	28,150,090	76,760	2,000,003	200,000
1890	3,735,140	500,024	2,351,504	200,000½

Besides which the following table gives the import and export of gold and silver during the last four years.

	1887.	1888.	1889.	1890.
	Roubles.			
Import.				
Gold in ingots, pouds . .	23·8	350·4	32·5	59
» » » value. . .	373,968	5,494,272	455,726	822,621
» coins, pouds. . . .	127·6	1,089·4	176·6	1,185
» » value	1,817,124	15,513,412	2,231,908	14,978,084
Silver in ingots, pouds. .	3,362	10,842	10,662	9,073
» » » value . .	2,955,106	9,541.268	7,484,461	6,368,912
» coins, pouds . . .	1,120	1,705	1,569	1,595
» » value. . . .	896,300	1,364,360	990,561	1,008,372
Export.				
Gold in ingots, pouds . .	214	1,403	0·4	—
» » » value. .	3,356,696	22,000,216	5,616	—
» coins, pouds. . . .	1,090·8	913	1,380·2	1,318
» » value	15,533,424	13,001,120	17,445,412	16,915,164
Silver in ingots, pouds. .	2,789	4,169	3,671	2,448
» » » value . .	2,453,924	3,668,940	2,576,709	1,718,777
» coins, pouds . . .	553	478	706	3,629
» » value. . . .	442,280	382,420	446,097	2,293,528

Copper.

The production of copper in the Urals dates from the middle of the seventeenth century, copper smelting was also begun in the Altai by Akinfi Demidov at the commencement of the eighteenth century. At the close of the last century the private copper works of the Urals alone smelted as much as 100,000 pouds of copper, while in 1816 the production of these works rose to 178,400 pouds, so that at that time the total yield of copper in Russia amounted to at least 200,000 pouds.

Starting from 1822 the production of copper in Russia was as follows.

	Quantity of copper smelted.	Average yearly production.		Quantity of copper smelted.	Average yearly production.
	Pouds.	Pouds.		Pouds.	Pouds.
1822–1825	774,666	193,666	1861–1865	1,412,758	282,552
1826–1830	1,115,945	223,189	1866–1870	1,364,533	272,907
1831–1835	1,134,310	226,862	1871–1875	1,148,514	229,703
1846–1850*	1,556,314	311,263	1876–1880	1,051,450	210,290
1851–1855	1,864,827	372,965	1881–1885	1,364,629	272,926
1856–1860	1,676,456	335,291	1886–1890	1,507,174	301,435

Up to 1845 the average yield of copper in Russia amounted to from 200 to 250 thousand pouds yearly, but during the following seven years this figure rapidly rose, and in 1852 the production already amounted to over 410,000 pouds. In the last century Russia supplied the whole of Europe with copper and up to the middle of the present, was one of the chief sources from which the European markets obtained their copper; the famous bronze industry of France was mainly dependent upon Russia for its metal. This period also corresponds to the fortifying of Paris and to the reinforcement of the French artillery previous to the Crimean war. The Russian copper-smelting works attracted so much interest on the part of French Government that they requested the Russian consul at Paris to inform them of the various trade marks of the Russian works, and advised the alteration of several marks which were likely to be counterfeited. The increased export of copper from Russia at this time raised the price and gave the possibility of increasing the production of the Russian copper-smelting works. But since 1852 the yield of copper in Russia has gradually fallen.

The liberation of the serfs in 1861 and the policy of the customs of 1857 to 1876 almost ruined the copper industry. At that time the Russian copper masters paid a tax of from one to one and a half roubles per poud, while the duty upon foreign copper was only sixty kopecks per poud. Under these conditions the production of copper decreased more and more, and in 1879 it was only 190,688 pouds or less than half of that for 1852. It was only in 1884 when half the copper works were already closed, that the duty upon foreign copper was raised to 1·50 roubles gold. But even this duty proved insufficiently protective, owing to the appearance of a new universal crisis in the copper industry, brought on by the larger development of the production of copper in the New World and the consequent fall in the price of the metal on all the

* Full data are wanting for the years from 1836 to 1845.

European markets. In order to sustain the copper industry which supports a large population in the distant parts of the Ural, Altai, Caucasus and Kirghis steppes, the duty was raised in 1886 to 2·50 roubles per poud. Since the yield of copper has again increased, and during the last ten years the production in Russia has varied as follows.

Year.	Urals.	Kirghis steppes.	Altai.	Finland.	Siberia.	Caucasus.	Total.
		P	o	u	d	s.	
1881	126,083	18,578	21,500	7,262	491	37,551	211,465
1882	128,934	19,100	16,800	5,908	—	48,538	219,280
1883	165,762	22,214	14,015	9,396	—	54 552	265,939
1884	221,985	34,500	24,000	11,658	—	87,544	379,687
1885	146,701	23,933	24,605	11,405	—	81,619	288,258
1886	149,742	4,038	17,800	13,110	—	94,366	279,056
1887	163,045	249	16,240	12,218	—	112,855	304,607
1888	156,777	308	18,200	12,345	—	93,385	281,015
1889	157,949	345	21,073	23,070	—	90,539	292,976
1890	173,307	—	19,337	17,544	—	139,332	349,520

During these ten years the production showed an increase of 138,000 pouds, or more than fifty per cent. This increase was, to a considerable extent, due to the development of the copper works in the Urals, and even more, to the rapid growth of the copper industry of the Caucasus which may be ascribed to the richness of the deposits, and to the technical perfection of certain works.

The largest output is given by the Bogoslov copper works in the Ural and the Kedabek works in the Caucasus. The former is notable from the fact that the copper ores are treated by the wet method and the copper deposited by electricity; they also refine the coarse metal in Bessemer convertors. At the Kedabek works they use naphtha refuse for fuel in the smelting furnaces. In the Kirghis steppes, renowned for the great richness of their deposits, the copper industry has entirely fallen, chiefly owing to the want of fuel. In the Altai the production of copper varies very slightly from year to year. In Finland however copper mining has recently increased to a marked degree. The general decrease in the yield of copper is not due to the exhaustion of the deposits, as copper ores are found in many parts of Russia.

In the Ural some works smelt the ores from veins and lodes, while others treat the ores of aqueous origin. The copper ores of the former category are situated on the eastern declivity of the Ural and they are all distinguished for the small amount of copper they contain, from three to seven per cent. These ores are chiefly pyritic, copper pyrites, copper glance, fahlerz, besides which azurite, malachite, red copper ore and native copper are met with. The works situated on the western declivity of the Urals smelt ores which occur in many localities in the form of masses disseminated in strata of the Permian system which are widely spread throughout the governments of Perm, Viatka, Kazan, Orenburg, Ufa and Samara. These ores are still poorer than the first, and only contain from two to three per cent of copper; they include azurite, emerald

copper, more rarely malachite, red and brown copper ore, and very rarely native copper. In the Caucasus the copper ores occur in veins which are widely distributed throughout the southern side of the mountain chain. These ores are chiefly sulphurous and are distinguished for their richness, which attains seven to fifteen per cent of copper. The deposits of the Kirghis steppes are the most favourable, both in respect to their size and richness. In this district there are vast deposits which frequently contain considerable masses of native copper, while the ores contain 25 to 33 per cent of metallic copper.

In 1890 there were 109 copper mines under exploitation, having a total output of 8,243,483 pouds of ore, the output of the previous year being 8,662,042 pouds, and locally distributed as follows:

	1889.	1890.
	Production in pouds.	
Ural	4,815,100	4,220,700
Altai	514,100	60,300
Khirghis steppes	161,300	13,300
Yenisei	1,100	—
Caucasus	1,458,700	2,225,500
Olonets	113,100	51,700
Finland	1,598,600	1,672,000

Owing to the diversity in the richness and facility of working the copper ores of the Ural the Government found it necessary in 1869 to change the previously existing tax of 10 per cent upon the yield of copper from freehold works, and of 15 per cent from works leased on State lands, to fifty kopecks per poud for the copper smelted from vein deposits upon freehold works, twenty-five kopecks per poud for that extracted from the sedimentary deposits of the western side of the Urals, one rouble for vein deposits and seventy-five kopecks for the sedimentary deposits smelted by works leased on State lands. This lowered the tax upon copper approximately thirty per cent. In the Caucasus a mining tax of fifty kopecks is levied on the copper smelted by freehold works and of seventy-five kopecks per poud on that smelted by works leased on State lands. At the present time the revenue collected by the Government from the copper industry amounts to from 150 to 180 thousand paper roubles yearly.

On turning to the foreign trade and consumption of copper in Russia it is found that in 1853 about 400,000 pouds of copper, having a value of at least four million roubles, were exported, while the amount of copper imported did not then exceed 3,000 pouds. Up to the year 1866 the export of copper, although it fell to an average of fifty thousand pouds, exceeded the import, or in other words, the internal production exceeded the requirements of Russia for this metal. Since 1867 the export has diminished, while the import has gone on increasing. Thus in 1880 the importation of copper amounted to 566,000 pouds, having a value of over 6,500,000 roubles, while the export did not exceed 82,000 roubles. The export of copper during the last ten years has varied as shown in the following table.

Years.	Copper exported from Russia.		
	Ingots.	Sheets.	Total.
	Pood.		
1881	—	—	14,000
1882	—	—	206,700
1883	—	—	35,500
1884	—	—	26,900
1885	17,900	2,300	20,200
1886	12,400	200	12,600
1887	10,150	400	10,550
1888	3,400	300	4,700
1889	4,000	500	4,500
1890	4,800	550	5,350

At the present time the chief consumers of Russian copper are Persia, which is supplied by the copper works of the Caucasus, and Germany. During the last ten years the importation of copper ingots into Russia has considerably risen, while the amount of sheet copper and of copper rods has decreased. The following table gives the imports of copper into Russia during the last ten years.

Years.	Copper ingots and scraps.	Sheet copper, copper rods and bars.	Total.
	Pood.		
1881	—	—	537,800
1882	—	—	127,500
1883	72,000	151,000	223,000
1884	97,000	184,000	281,000
1885	109,000	87,000	196,000
1886	105,214	28,844	134,058
1887	37,057	13,732	50,789
1888	25,649	8,164	33,813
1889	219,844	22,395	242,239
1890	246,159	22,018	268,177

The following data show what countries participated in supplying Russia with copper, and to what extent.

Countries.	Copper ingots and scraps.			Sheet copper, copper rods and bars.		
	1888.	1889.	1890.	1888.	1889.	1890.
	Pood.			Pood.		
From Great Britain	2,000	117,100	136,200	600	9,900	11,200
» Germany	11,800	56,400	82,600	6,400	10,800	8,300
» Holland	300	6,250	7,500	200	—	—
» France	—	12,000	2,500	—	—	500
» Belgium	—	2,200	600	—	600	900
» Austro-Hungary	—	—	—	80	700	—
» Italy	—	—	400	—	—	—
» Turkey	—	—	—	—	260	500
» Denmark	—	1,100	—	—	—	—

According to the customs tariff of 1891 the following duties were put on copper, aluminium, nickel, cobalt, bismuth, cadmium, brass, tompak, britannia, and all alloys of the non-noble metals, beyond those specially named above:

1. In the form of pig copper, ingots, turnings, fillings and scrap, and also in copper in the form of powder, 2·50 roubles in gold per poud.

2. In the form of bars, rods and sheets, 3·10 roubles in gold per poud.

3. On copper and its alloys when rolled or drawn into wire, half an inch or less in width, or diameter, the duty is the same as for copper wire, namely:

a. On all telegraph cables from half an inch in width or diameter to № 25, inclusive of the Birmingham guage, a duty of four roubles per poud.

b. Above № 25 to № 29 inclusive, five roubles per poud.

c. Finer than № 29, six roubles per poud.

Lead.

Lead is only obtained together with silver from argentiferous lead ores. In general the amount of lead smelted in Russia is very inconsiderable and is expressed by the following figures during the last sixty years.

Years.	Amount of lead smelted.	Average yearly production.	Years.	Amount of lead smelted.	Average yearly production.
	Poud s.			Poud s.	
1831—1835	209,696	41,939	1866—1870	476,416	95,283
1836—1840	245,492	49,098	1871—1875	387,671	77,534
1841—1845	292,180	58,436	1876—1880	382,864	76,573
1846—1850	259,794	51,959	1881—1885	210,590	42,118
1861—1865 *	357,106	71,421	1886—1890	243,144	48,629

All the lead smelted in Russia is obtained from the argentiferous lead ores of the Caucasus and Siberia. In the Caucasus the ore is mined at the Alagirsk Government Works, and in Siberia at the Altai and Nerchinsk mining districts of His Majesty's Cabinet, and also in the Kirghis steppes, where the exploitation of the lead ores is carried on by private individuals. Lead was only smelted as an independent product at one set of works in Turkestan. These works were constructed in 1881 and only kept in operation till 1885. Besides this, argentiferous lead ores are known to exist on the Mourman coast in the government of Archangel. A private company has recently been formed for working these ore deposits which were only fully surveyed in 1890. Private individuals are also endeavouring to make a detailed survey of the argentiferous lead deposits of the government of Ekaterinoslav, and to start the smelting of these metals there. The actual smelting of lead is carried on only in four districts whose production during the last ten years is shown in the following table.

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* Complete data are wanting for the production of lead during 1850 to 1860.

Years.	Altai.	Nerchinsk.	Caucasus.	Kirghis steppes.	Total.
	Pouds.				
1881	41,670	8,927	9,620	—	60,217
1882	14,890	7,775	9,292	—	34,957*
1883	16,385	6,884	9,895	—	33,164
1884	20,083	7,369	8,455	2,693	38,600
1885	16,706	7,597	9,115	3,186	43,651**
1886	22,079	7,690	8,755	8,937	47,461
1887	31,117	8,356	9,592	11,363	60,428
1888	10,099	7,205	8,962	22,544	48,810
1889	6,653	7,896	9,929	10,836	35,314
1890	19,305	7,827	9,306	14,693	51,131

The fact that Russia produces so inconsiderable a quantity of lead clearly indicates that it is dependent upon foreign countries for its supply of a metal so indispensable. Indeed the following data show that Russia annually imports about a million pouds of lead.

Years.	Pig lead and scrap.	Lead sheets, rolls and pipes.	Total.
	Pouds.		
1883	939,000	147,000	1,086,000
1884	934,000	137,000	1,071,000
1885	398,000	125,000	523,000
1886	654,972	170,452	825,424
1887	928,516	150,289	1,078,805
1888	1,037,479	175,490	1,212,969
1889	1,010,607	191,858	1,202,465
1890	1,116,355	202,521	1,318,876

During the last three years the imports of lead have been as follows.

Countries.	Pig and scrap lead.			Sheet, roll and pipe lead.		
	1888.	1889.	1890.	1888.	1889.	1890.
	Pouds.					
From Great Britain	375,400	522,800	702,800	117,500	150,100	159,100
» Germany	476,100	289,100	229,800	28,100	21,950	25,800
» France	89,400	131,300	86,900	7,900	10,000	11,500
» Belgium	50,200	41,800	43,300	700	1,900	1,300
» Holland	10,900	14,500	28,900	—	—	—
» United States	3,100	—	9,300	—	—	3,200
» Denmark	600	—	3,000	—	—	—
» Austro-Hungary	—	1,300	1,500	2,800	400	800
» Turkey	13,600	400	—	700	700	—
» Italy	5,300	3,100	—	—	—	—

* Including 3,000 pouds smelted at the Turkestan works.

** Including 7,047 pouds smelted at the Turkestan works.

According to the customs tariff of 1891 lead imported into Russia is subject to the following duty:

1. Lead in pig and scrap, litharge, lead ash, 10 kopecks in gold per poud.
2. Lead in rolls, sheets, wire and pipes 30 kopecks in gold per poud.
3. Type metal 20 kopecks per poud in gold.

Zinc.

All the Russian zinc works are situated in Poland, although deposits of zinc ores are also known in other parts of the Empire, for instance in the Caucasus, southern Russia, on the Mourman coast of the government of Archangel, in Siberia, and also in Finland. The annexed table gives the production of zinc since 1836.

Years.	Production of zinc.	Average yearly production.	Years.	Production of zinc.	Average yearly production.
	Pouds.			Pouds.	
1836—1840	856,103	171,221	1866—1870	972,233	194,447
1841—1845	768,585	192,146	1871—1875	1,052,852	210,570
1846—1850	823,900	184,780	1876—1880	1,387,708	277,542
1851—1855	447,425	89,485	1881—1885	1,317,850	263,570
1856—1860	435,730	87,146	1886—1890	1,169,254	233,851
1861—1865	831,072	166,216			

In Poland, zinc is exclusively extracted from calamine, deposits of which are chiefly worked in the neighbourhood of Olekousha where the exploitation of argentiferous lead ores has been carried on for several centuries. These lead deposits lie in the upper portion of the strata from which the calamine is now extracted. The zinc ore here occurs in a dolomite formation and contains from eight to fifteen per cent of metallic zinc. A portion of the zinc here produced goes to the interior of Russia in the raw state and is chiefly used for the manufacture of brass, the remainder is rolled into sheets at the two existing works of Poland whose yearly production is from 150,000 to 200,000 pouds of sheet metal. There are also works for the preparation of zinc white at the same locality, and which turn out about 50,000 pouds yearly.

Since 1888 a mining tax of eight kopecks per poud has been placed upon the pig zinc manufactured in Russia. This brings in an annual revenue of 18,000 paper roubles to the Government. The amount of zinc produced in Russia is far from sufficient to supply the increasing demand, so that a considerable quantity of the metal is annually imported into Russia, as is seen from the following table.

Years.	Imports of zinc.		
	Zinc in pigs.	Zinc in sheets.	Total.
	Pouds.		
1881	99,400	42,300	141,700
1882	140,400	11,000	151,400
1883	132,600	16,000	148,600
1884	211,600	33,500	245,100
1885	173,000	9,600	182,600
1886	151,196	13,168	164,364
1887	40,244	8,373	48,617
1888	60,821	23,549	84,370
1889	186,310	57,760	244,070
1890	299,113	34,009	333,122

The importation of sheet zinc, which in 1879 amounted to 163,000 pouds, rapidly fell after the new zinc rolling works were built in 1880 in Poland. The returns of the customhouse show the exportation of zinc abroad, but a considerable portion of this zinc was re-imported into Russia, as owing to the high railway rates the Polish zinc was forwarded to St. Petersburg by sea through Stettin. The following table indicates what countries participated in furnishing Russia with zinc, and to what extent.

Countries.	Pig zinc.			Sheet zinc.		
	1888.	1889.	1890.	1888.	1889.	1890.
	Pounds.					
From Germany	45,100	166,500	254,100	16,100	48,400	28,200
» Great Britain	5,300	8,800	23,000	3,900	3,200	400
» Holland	6,150	8,250	14,200	—	—	—
» Belgium	3,400	2,800	4,000	3,450	900	2,100
» Denmark	—	900	1,900	—	—	—
» Austro-Hungary	—	1,200	1,200	—	700	400
» France	700	—	—	—	—	2,800

According to the customs tariff of 1891, zinc imported into Russia is subject to the following duties:

1. Pig zinc and scrap, 50 kopecks in gold per poud.

2. Sheet zinc, one rouble in gold per poud.

Sheet zinc coated with nickel or other metals is subject to an extra duty of thirty per cent above that put upon sheet zinc; that is, 1·30 roubles per poud.

Tin.

Deposits of tin are only known in Finland and in the Baikal province of Siberia. At the present time tin is only smelted at the Pitkaransk works in Finland, and that only in very inconsiderable quantities. The production of these works has especially fallen since the seventies, but during recent years it has again begun to rise. During the last ten years the following amounts of tin were smelted at these works:

Years.	Production of tin. Pounds.	Years.	Production of tin. Pounds.
1881	604	1886	1,038
1882	320	1887	629
1883	1,117	1888	1,186
1884	765	1889	721
1885	860	1890	804

In general the yearly demand in Russia for tin is over 100,000 pouds, so that the above internal production is utterly insufficient for home requirements. Therefore, a large quantity of tin is imported as the following figures show:

	Imports of tin.		
1881	126,900 pouds.	1886	106,000 pouds.
1882	89,100 »	1887	111,000 »
1883	114,300 »	1888	143,700 »
1884	111,400 »	1889	132,600 »
1885	78,700 »	1890	161,400 »

During the last three years the following countries have been the chief sources from which Russia has imported tin:

Imports of tin.

Countries.	1888. Poud s.	1889. Poud s.	1890. Poud s.
Great Britain	100,300	91,300	92,600
Holland	22,300	21,700	34,300
Germany	15,800	15,600	17,900
France	1,300	600	14,300
Belgium	700	1,900	600

Under the customs tariff of 1891, tin imported into Russia is subject to the following duties:

1. Pig tin, rods and scrap, 45 kopecks in gold per poud.

2. Sheet tin, mirror backs, and lead sheets coated with tin, 1 rouble in gold per poud. Tin sheets and lead sheets coated with tin, and colored or covered with coloured varnish pay a duty of 1·50 roubles.

MERCURY.

Deposits of mercury ores were first discovered in Russia in 1879 in the government of Ekaterinoslav near the station of Nikitovka on the Kursk-Kharkov-Azov Railway. Mercury has also been recently discovered in the Caucasus at Daghestan but these deposits have not yet been opened out. The deposits near the station of Nikitovka lie in strata of the carboniferous system, and consist of cinnabar which fills the crevices in sandstone. The exploration of these deposits proved that they occupy an exceedingly large area. Traces of ancient workings were also brought to light, and notwithstanding that they extend over a distance of about two versts there is no record of the epoch to which they belong.

These deposits were first worked in 1885 by the present owners, A. A. Auerbach and Co., who in 1886 built small works capable of turning out about four thousand pouds of mercury annually, which corresponded to the internal consumption of Russia. But already in 1887 these works were considerably enlarged owing to the evident possibility of a considerable market being found abroad. The mines and works are models of their kind, and are better organized and work on a more economical and rational basis than those of Idria and Almaden. At the present time the locality of the works which in 1885 was a bare steppe is now occucied by a busy population of over 1,500 inhabitants. The production of these mines and works is shown in the following table.

Years.	Production of ore.	Production of metallic mercury.
	Poud s.	
1887	762,300	3,911
1888	2,005,250	10,062
1889	3,074,450	10,202
1890	3,686,680	17,835

In 1890 there were 687 men employed on the mercury mine and works. In 1892 the Russian Government seeing that the mercury industry had taken firm root, placed a mining tax of 50 kopecks per poud upon the mercury produced in the Empire. It is estimated that in 1893 this tax will bring in a revenue of 12,000 paper roubles. Up to 1886 Russia annually imported from 2,000 to 5,000 pouds of mercury having a value of from 85,000 to 200,000 roubles, but since 1887 this amount has fallen to 250 pouds. Indeed now a considerable portion of the mercury produced in Russia is sent abroad, thus in 1889, 7,805 pouds were exported, and in 1890, 13,855 pouds having a value of 642,916 roubles. This mercury goes exclusively to Germany. According to the customs tariff of 1891 mercury imported into Russia is subject to a duty of 2.40 roubles in gold per poud.

Manganese.

Deposits of manganese ore are known in the Caucasus, south of Russia and Urals. The exploitation of manganese ores is chiefly carried on in the Transcaucasus, where the workings are almost exclusively limited to the Sharapan district of the government of Kutais. However the production of manganese ore is also carried on to a small extent in the district of Kutais and in the government of Tiflis.

The richest deposits occur in the district of Sharapan at Chiatoura and extend over an area of about a hundred and twenty square versts, divided by the river Kvirila which with its tributaries passes through deep ravines and has laid bare the ore deposits. The deposits vary from five to seven feet in thickness and contain from six to eleven layers of manganese, about five inches thick. The exploitation of these deposits was first started in 1879. At first they were only worked by large capitalists, but they met with competition on the part of the small landowners of the district, in consequence of which the price of the ore began to fall. Owing to this circumstance the larger enterprises by degrees stopped working and at the present time the manganese industry is mainly in the hands of small capitalists who in the majority of cases do not understand mining matters, and consequently work the deposits in a most irrational manner. At first there was great difficulty in transporting the ore from the mines to the railways, about fifty versts distant, but now this difficulty has been overcome by the construction of a special branch line to the mines from the main line of the Transcaucasian Railway. The ore worked in the district of Sharapan contains 56 per cent of metallic manganese, and in general is distinguished for its fine quality as is shown by analysis made at New Castle.

There are also deposits of manganese ore, which however contain a somewhat smaller percentage of manganese, at a short distance from the Transcaucasian Railway, and much nearer the Black Sea. These deposits are situated near the Samtredi and Novo-Senaki Railway stations.

In the Urals, manganese ores are worked in the government of Perm in the region of the Nizhni-Taghilsk works, and also in the government of Orenburg in the district of Verkhneuralsk. Deposits of manganese ores are also known to exist in the government of Ekaterinoslav near Nikopol, where they occur in beds as much as half a sagene thick on strata of the Eocene formation. These deposits were first worked in 1886, and now there are two mines from which the ore is raised. According to foreign analysis the ore of the government of Ekaterinoslav contains about 57 per cent of peroxide of manganese.

The total production of manganese ore in Russia during the last ten years is given in the following table.

Years.	Caucasus.	Ural.	Ekaterinoslav.	Total.
	Pouds.			
1881	686,100	—	—	686,100
1882	763,000	118,000	—	881,000
1883	975,000	66,000	—	1,041,000
1884	1,263,000	88,300	—	1,351,300
1885	3,640,800	54,700	—	3,695,500
1886	4,242,100	50,000	250,000	4,542,100
1887	3,277,200	50,000	226,350	3,553,550
1888	1,822,800	82,700	89,600	1,995,100
1889	4,243,200	179,100	341,500	4,763,800
1890	10,468,100	143,500	528,100	11,139,700

The greater portion of the manganese ore raised in Russia is sent abroad, and only a small quantity is smelted into ferro-manganese on the spot *. In 1890 the Ural works produced 22,000 pouds of ferro-manganese and spiegeleisen and the works of southern Russia, 617,300 pouds.

The accompanying table gives the export of Russian manganese ore during the last nine years.

Years.	Export of manganese ore.	Years.	Export of manganese ore.
1882	562,700	1887	3,690,400
1883	871,500	1888	3,042,700
1884	1,247,800	1889	3,440,300
1885	2,567,000	1890	8,129,500
1886	3,403,400		

The following table gives the amounts exported to the different countries during the last three years. It should be remarked however that the ore imported by Holland was probably destined for German works, and also, that all goods transported by sea to Gibraltar are shown as exported to Great Britain, although some vessels are registered to Gibraltar only, hence the following data cannot be regarded as absolutely correct.

Countries.	Manganese ore.		
	1888.	1889.	1890.
	Pouds.		
Great Britain	1,627,800	2,348,400	5,275,000
Holland	768,000	349,000	1,466,700
France	276,700	121,600	511,500
Germany	250,500	303,400	439,400
United States	—	9,400	400,100
Belgium.	132,000	104,700	104,800

* In 1890, 478,676 pouds of manganese ore were smelted.

Cobalt and Nickel.

Cobalt is solely produced in the Caucasus at the Dashkesan works situated in the government of Elisavetpol. Cobalt speiss was for the first time produced in Russia at the above-mentioned works in 1867 when 1,300 pouds of speiss wire were smelted. Since then the preparation of cobalt has been continued, although there have been intervals of several years when the production has ceased.

Deposits of nickel ore are known in various parts of the Urals, and also in the Caucasus in the province of Daghestan. The richest deposits of nickel ore in Russia occur in the Revdin mining district of the Urals. Still there is every possibility of similar deposits being found in other parts of the Urals. The deposits in the Revdin district were first discovered in the fifties, and the Petrovsk mine was subsequently laid out for working them. This in the only instance known in Europe of a mine working oxidized nickel ores almost free from sulphur and arsenic. The percentage of nickel varies, but may be said to average about two per cent. The first experiments of smelting nickel were made in the beginning of the sixties, but there is no account of the preparation of nickel before 1874, since when about 3,600 pouds were smelted. The constant extension of the practical applications of this metal, even for the army, may give a particular importance to the deposits of the Urals, and there is even reason to suppose that with the general scarcity of nickel ores Russia may become one of the chief sources of this metal.

The iron industry.

The working of iron ores and their treatment in cold blast furnaces was carried on from ancient times in the government of Novgorod in the neighbourhood of Ustiuzhina, afterwards called Zhelesnopol. To this day there exist many traces of these workings in the present government of Olonets and at the village of Dedilov in the government of Tula. The manufacture of pig iron and the treatment of iron on a larger scale was first developed in central Russia and in the governments of Olonets and Perm where not only rich deposits of ore but also an abundance of wood occur, together with other natural and economical conditions favourable to the development of the iron industry. By degrees the number of works increased and the iron industry took root in localities where it had previously not existed. Still the chief centres of the iron industry were always the Urals, central Russia and Poland, but in recent times the greatest production is given by South Russia *.

The works of eastern Russia, namely of the governments of Perm, Viatka, Ufa and Orenburg belonging to the so-called mining regions of the Urals, chiefly smelt magnetic and brown iron ore. Red hematite, siderite and sphero-siderite are smelted in comparatively small quantities. The most remarkable deposits of magnetic iron ore occur at Mounts Blagodat and Visokaia in the central Urals in the government of Perm and at Mount Magnitnaia in the south Urals, government of Orenburg. The deposits of Mount Visokaia, which furnish several mining districts with ore, yield above eight million pouds annually. This ore contains from 63 to 69 per cent of iron and can be smelted without the addition of any fluxes. Mount Blagodat annually yields over three million pouds of ore, containing from 52 to 58 per cent of iron. This ore, however, requires the

* See map of the iron and steel producing regions.

MAP OF EUROPEAN RUSSIA

indicating pig iron, iron and steel regions.

Cartographical works, A. Jlyne, St. Pbg.

Regions of productiveness.

Productiveness of pig iron, in pouds, in 1890.

Productiveness of iron and steel, in pouds, in 1890.

addition of a small quantity of limestone flux. The ore of Mount Magnitnaia is very pure and rich, containing as much as 66 per cent of iron, nevertheless this deposit is very little worked owing to its distance from iron works and the want of means of communication.

Besides these three chief localities a more or less considerable amount of magnetic iron ore is yielded from several deposits on the eastern side of the Urals. In 1874 an extensive deposit of specular iron was discovered in the north of the Urals and in 1890 the Koutimsk iron works were built for smelting this ore. Most extensive deposits of brown iron ore of a very high quality, yielding pig iron suitable for the Bessemer process, occur in the central and south Urals. This ore sometimes gives as much as 60 per cent of iron in smelting. Deposits of spherosiderite occur in many parts of the government of Viatka and in the western portion of the government of Perm. In general these ores are not rich and contain some phosphorus.

The deposits of red hematite on the western slopes of the Urals deserve special mention. The ore here occurs in strata of the carboniferous formation and yields as much as 64 per cent of iron in smelting. In speaking of the iron ores of the Urals, it is impossible to avoid mentioning the deposits of chrome iron ore, which occur in several localities in this region. The chrome iron ore here produced is partly smelted in blast furnaces and partly exported. The ore contains from 35 to 38 per cent of oxide of chromium and about 40 to 50 per cent of iron.

The iron district of central Russia includes the governments of Nizhni-Novgorod, Vladimir, Riazan, Tula, Kalouga and Oriol. The ores worked are brown iron ore and siderite. As a rule the ores of Central Russia are easily reducible but in the majority of cases are not distinguished either for their richness or purity as they often contain phosphorus. However, they are very suitable for the manufacture of cast iron.

The government of Olonets and Finland are rich in lake and bog iron ores. Unfortunately the majority of these ores are poor and phosphoritic. Numerous deposits of other iron ores, such as magnetic iron ore and specular iron, are known in these localities. Numerous deposits of brown iron ore occur in the west of Russia in the governments of Vilna, Minsk and Volyn. A considerable quantity of spherosiderite containing from 27 to 35 per cent of iron and brown iron ore with from 35 to 45 per cent of iron is raised in the south and west of Poland, but the majority of these ores are phosphorites.

From the time of its exploration by the French savant Le Play, the Don coal basin of the south of Russia has always been known to be exceedingly rich in iron. The ores of this district are chiefly brown iron ore which occurs in strata of the carboniferous formation. Besides this, in the south of Russia there are vast deposits of exceedingly pure and rich ores with 60 to 68 per cent of iron. These deposits, which chiefly consist of specular iron, magnetic iron ore and red hematite, occur on the borders of the governments of Kherson and Ekaterinoslav in the neighbourhood of the village of Krivoi-Rog. The exploitation of these deposits has been rapidly developed, and in 1890 more than 19,000,000 pouds of ore were yielded by seven mines worked upon the open-working system. Besides this there is a deposit very favourably situated of magnetic iron ore near Korsak-Mogila in the Tauride government about thirty versts distant from Berdiansk, one of the ports of the Azov Sea.

The following table gives the yield of iron ore in different parts of Russia during the last five years.

Regions.	1886.		1887.		1888.		1889.		1890.	
	№ of mines.	Yield of ore. Pouds.	№ of mines.	Yield of ore. Pouds.	№ of mines.	Yield of ore. Pouds.	№ of mines.	Yield of ore. Pouds.	№ of mines.	Yield of ore. Pouds.
Urals	441	41,741,300	490	47,474,500	522	49,264,700	498	51,111,700	435	56,268,200
Central Russia	29	7,134,400	20	8,356,500	20	8,627,300	20	10,228,600	22	12,272,800
South Russia.	12	5,563,500	15	10,008,300	20	13,994,900	22	21,007,900	22	22,997,500
Poland	69	7,661,000	68	8,782,500	63	12,148,900	79	13,306,500	49	13,394,700
Siberia	8	731,300	9	831,000	7	795,600	4	783,200	5	759,900
North Russia	10 lakes.	433,700	14 lakes.	509,500	17 lakes.	481,200	1 mine. 13 lakes.	1,009,900	15 lakes.	571,500
Finland	1 mine. 67 lakes.	1,504,900	63 lakes.	6,792,200	132 mine.	2,203,500	1 mine. 164 lakes.	2,660,000	1 mine. 180 lakes.	3,125,000
Total.	623 and 77 lakes.	66,460,000	602 and 77 lakes.	82,753,500	632 and 149 lakes.	85,516,100	645 and 177 lakes.	100,107,800	536 and 195 lakes.	109,622,000*

* Including 317,400 pouds in the Caucasus.

The following table gives the amount of iron ores smelted in the blast furnaces of the Empire during the last nine years.

Ores.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
	Thousands of pounds.								
Magnetic iron ore	11,095	12,193	13,129	13,244	13,924	15,638	18,251	12,763	17,703
Brown iron ore	35,044	31,131	32,060	34,333	36,879	42,029	43,049	51,101	46,348
Red hematite	14,186	17,003	14,310	16,932	12,800	16,790	14,918	11,206	21,836
Siderite and clay iron stone								8,534	14,013
Lake and bog ore							5,065	1,861	2,938
Other ores							—	—	493
Slag, cast iron and scrap	726	1,244	1,659	2,154	2,674	3,582	4,256	5,728	7,546
Total.	61,052	61,571	61,158	66,664	66,277	78,039	82,539	91,194	110,878

This table shows that between 1882 and 1890 the consumption of magnetic iron ore increased sixty per cent while the consumption of brown iron ore only increased a little over thirty per cent. Red hematite is chiefly smelted by the iron works of south Russia, which consume large quantities of ore from the deposits at Krivy-Rog. A striking feature in this table is the large increase in the amount of slag smelted, which from 726,000 pouds in 1882 rose to 7,546,000 pouds in 1890, that is, more than ten times. About half of this quantity, namely 3,506,000 pouds, was consumed by the tin iron works of Poland, while the thirty-six works of the Urals only smelted 1,372,000 pouds of slag during the same year. This may be ascribed to the fact that in the Urals the ores are far richer in iron than the slags and cost comparatively little, while the works of Poland smelt exceedingly poor ores which, moreover, are rather expensive.

The manufacture of pig iron is mainly carried on by charcoal fuel. The charcoal is either prepared in stoves or in stacks, and chiefly from pine and birch wood. Pine and birch charcoal are preferred for fuel for blast furnaces. In Poland oak and beech wood are also used for the preparation of charcoal for the blast furnace. Sometimes in central Russia and Finland the charcoal is mixed with wood, and peat is occasionally added in Poland. There are also blast furnaces working on a mixture of charcoal and coal. In 1890 there were seven such furnaces in Poland and one in the Urals. In 1890 there were five blast furnaces working exclusively upon coal in Poland and seven in the south of Russia upon coke. At the Sulinovsky works in the south of Russia there was one furnace working upon anthracite.

The charcoal furnaces are frequently very primitive in their design, with massive brick or stone boshes, and cold or feebly heated blast of low pressure. Even in 1870 when the Austrian metallurgist Tunner visited the Urals he expressed his astonishment at the fact that the hot blast was nowhere used. The blast furnaces vary considerably in capacity and height. Thus in Finland, Poland and the government of Olonets the blast furnaces working with charcoal are chiefly small, not exceeding thirty to thirty-five feet in height; but in the Urals they are large and high, fifty feet and more, the furnaces of central Russia being intermediate between the two. In general the

furnaces of recent construction are distinguished for their large capacity, greater number of tuyeres, from three to twelve, which are often cooled by a current of water. In the new furnaces the hearth is accessible from all sides and like the shaft is most often built of brick. The external walls of the new furnaces are made comparatively thin and some are built upon the Scotch system without external casing. The furnaces of the newest pattern are generally furnished with a gas-collecting apparatus and work with a hot blast. The blast furnaces working with mineral fuel are for the most part of the newest construction with an annual yield of two and one-half million pouds of pig iron.

The changes which the manufacture of pig iron has undergone during the last ten years are seen in the accompanying table giving the number of furnaces worked with cold and hot blast and the production of pig iron with charcoal and mineral fuel.

Years.	№ of furnaces.			Production of pig iron in pouds.		
	Cold blast.	Hot blast.	Total.	Charcoal fuel.	Mineral fuel.	Mixed fuel.
1881	—	—	196	26,446,443	2,215,277	—
1882	110	90	200	25,757,688	2,479,339	—
1883	106	96	202	26,660,810	2,746,121	—
1884	91	107	198	28,327,752	2,777,860	—
1885	88	107	195	28,660,621	3,003,563	541,320
1886	85	107	192	27,145,526	4,142,775	1,196,116
1887	70	119	189	30,184,803	5,990,827	1,213,641
1888	67	133	200	31,083,651	8,267,697	1,364,328
1889	74	139	213	31,602,782	11,968,222	1,609,301
1890	69	145	214	37,326,643	18,278,381	955,050

This table shows that while in 1882 fifty-five per cent of the blast furnaces in Russia worked with cold blast there only remained thirty-two per cent in 1890. During the same period the number of furnaces working upon mineral fuel increased from three to thirteen. As regards the production of pig iron with mineral fuel, in 1881 it did not exceed 7·7 per cent of the total production of the Empire, while in 1890 it had risen to 32 per cent of the total, having increased over eight fold during the ten years.

The iron works of Russia were formerly for the most part built on the banks of dammed up rivers. These works enjoy an immense supply of water which they store in vast reservoirs, often several square versts in area. The works therefore chiefly depend upon water power and are generally furnished with water wheels, which however are now being replaced by turbines and steam engines. The following table compares the number of different engines employed in the iron works of Russia in 1882 and 1890.

Class of Engine.	1882.		1890.	
	Number.	H. P.	Number.	H. P.
Water wheels	1,547	27,097	931	20,507
Turbines	163	8,261	362	18,593
Steam engines	726	31,432	904	57,148
Portable engines	74	—	126	—

This indicates a distinct progress in the application of steam power and turbines to the iron industry.

In the Urals forge pig iron is chiefly produced, especially if the ore used is magnetic iron. Thanks to the comparative purity of the ore from the chief deposits of the Urals the pig iron produced therefrom is distinguished for its great purity and is often quite suitable for conversion into steel. Foundry pig iron of excellent quality is smelted at certain works in the governments of Perm and Viatka. The Kousinsk and Kaslinsk works are known for the fineness of their castings made direct from the blast furnace. The works of central Russia, Poland and Finland manufacture both forge and foundry pig. The works of the government of Olonets prepare the latter exclusively, while only one blast furnace of the large works, built in the south of Russia and smelting with mineral fuel, produces foundry pig iron.

The greater portion of the pig iron smelted in Russia is converted into iron and steel by means of fuel supplied from the same forests which furnish the blast furnace with fuel. Only the south of Russia and Poland take advantage of the local coal for this purpose. Coal imported, chiefly from England, is used by the iron and steel works in St. Petersburg and its neighbourhood, and also by some of the works in the interior.

Turning to the actual manufacture of iron it is seen that up to about 1850 it was almost entirely conducted in bloomery furnaces. It was not before 1845 that the Ural iron works began to replace the ordinary bloomery furnaces for the k a n t o u a z pattern, and afterwards to introduce the puddling process, which was also introduced into the governments of central Russia about the same time. The bloomery process still continues to be employed in the Urals but in other parts of Russia it has been quite supplanted by the puddling process. In 1890, 377 or 84 per cent of the 451 bloomery furnaces in work in the whole of Russia belonged to the iron works of the Urals, and about 30 per cent of the iron produced in this district is obtained by the bloomery process. The continuation of the bloomery process in the Urals is partly due to the fact that the forests having gradually receded from the works, it is impracticable to transport the wood required for the puddling furnace, while the charcoal for the bloomery process is far more easily conveyed to the works, another reason being that some markets, such as the Asiatic, have a special demand for bloomery iron.

The puddling furnaces are either simple draught, gas simple draught, or Siemens furnaces. The gas simple draught furnaces are for the most part after Bäetius pattern. Although as a rule the puddling works, being of newer construction, are more complete than the bloomery and blast furnace works, still the employment of the waste heat from the puddling furnaces is rarely met with.

The manufacture of steel has been rapidly developed during the last twenty-five years. The reason of this will be discussed in speaking of the rail industry. Here it will only be mentioned that in 1851 Mr. Oboukhov, a mining engineer, invented a process for the preparation of crucible steel on a large scale. At first only cuirasses and swords were manufactured out of this steel, but it was soon employed for casting guns. The Zlatoust works were then built for this purpose and turned out ordnance of high quality. The difficulty of transporting heavy ordnance from the Zlatoust works to the fortresses, chiefly situated upon the shores of the Black and Baltic seas, induced the Government to build a cast iron and steel gun factory near the town of Perm on the river Kama. The crucible process was introduced at these works for the preparation of steel.

The Perm steel gun factory was constructed by Mr. Vorontsov, mining engineer, who in 1875 also erected a fifty-ton steam hammer for the works. The bed of this hammer weighed 525 tons and was cast in one piece. At that time this casting was unequalled throughout the world.

When the Zlatoust works were closed Mr. Oboukhov erected a steel gun factory near St. Petersburg; this factory now belongs to the Government. In the manufacture of steel it has been Russia's endeavour to keep pace with foreign works. When the Bessemer process was first announced several Government and private works in the Urals began to make experiments with a view to adopting it. The preparation of steel from phosphortic pig by the Gilchrist process was also quickly adopted in Russia. The accompanying three tables show the gradual process of development in the manufacture of pig iron, iron and steel in Russia. The data respecting pig iron begin from 1822; iron, from 1837; and steel, from 1847.

Production of pig iron.

Years.	Production of pig iron.	Average yearly production.	Years.	Production of pig iron.	Average yearly production.
	Poods.			Poods.	
1822—1825	36,616,164	9,154,041	1856–1860	82,809,707	16,561,941
1826–1830	53,711,844	10,742,377	1861—1865	88,328,097	17,665,619
1831—1835	52,498,248	10,499,850	1866—1870	97,981,395	19,596,279
1836—1840	54,596,471	10,919,294	1871—1875	119,084,592	23,816,918
1841—1845	56,030,734	11,206,147	1876—1880	130,754,907	26,150,981
1846—1850	62,515,519	12,503,104	1881—1885	149,616,794	29,923,359
1851—1855	69,717,572	13,943,514	1886—1890	212,329,743	42,465,949

Production of iron.

Years.	Production of iron.	Average yearly production.	Years.	Production of iron.	Average yearly production.
	Poods.			Poods.	
1837–1840	27,134,154	6,783,538	1866–1870	65,962,111	13,192,422
1841–1845	38,167,751	7,633,550	1871—1875	84,406,478	16,881,296
1846—1850	43,763,406	8,752,681	1876—1880	85,773,167	17,154,633
1851—1855	54,011,452	10,802,290	1881—1885	99,929,753	19,985,951
1856—1860	58,410,847	11,682,169	1886—1890	119,530,506	23,906,101
1861—1865	56,266,163	11,253,233			

Production of steel.

Years.	Production of steel.	Average yearly production.	Years.	Production of steel.	Average yearly production.
	Poods.			Poods.	
1847—1850	250,337	62,584	1871—1875	2,863,838	572,768
1851—1855	347,714	69,543	1876—1880	39,301,366	7,860,273
1856–1860	519,260	103,852	1881—1885	70,985,080	14,197,016
1861—1865	811,738	162,348	1886—1890	80,996,150	16,199,230
1866–1870	2,232,414	446,483			

The above tables show that during the last seventy years the production of pig iron has only increaced by four and a half times, and that at the present time Russia, which seventy years ago produced one and one-half times as much pig iron as France, four and a half times as much as Germany, three times as much as Belgium and as much as the United States, stands far behind all these countries in its production of pig iron. The chief reason for this regrettable state of affairs most certainly lies in the fact that Russia, owing to the force of circumstances, has always been dependent upon charcoal for the manufacture of its pig iron, while the other nations, having applied mineral fuel in far greater proportions or having totally ceased smelting pig iron with charcoal, have made rapid strides and have forged ahead. Moreover, the active rise in the production of pig iron during the last five years was mainly due to the firm establishment of its manufacture with mineral fuel, and there is every reason to foresee that the south of Russia will rapidly develop its production to an exceedingly large extent, and that the chief production of pig iron in Russia will be concentrated, just as it is in western Europe and America, where rich deposits of iron ores occur in the near neighbourhood of coal veins suitable for metallurgical purposes.

The combined production of iron and steel has also increased by four and one-half times during the last forty-five years. The manufacture of iron and steel is not subject to any Government tax, but a mining duty is collected on the production of pig iron. This duty amounts to one and one-half kopecks per poud on the pig iron smelted at freehold works, and two and one-half on that smelted at works leased from the Government. The revenue thus brought to the Government by the private iron works averages from six to seven hundred thousand paper roubles a year.

Before reviewing the production of the different iron centers of Russia it may be well to refer briefly to the history of the iron industry in the chief of these centres. In the Urals the metallurgical industry began to take root in the beginning of the seventeenth century when the Government built the first iron works. The discovery of iron ores near the river Nitsa was followed in 1631 by the erection of the first iron works in the Urals, called the Nitsinsk works. At these works, as was usual in those days, wrought iron was manufactured directly from the ore in hearths with an artificial blast. The metallurgical industry was placed on a perfectly firm footing in the Urals by Peter the Great, who in 1701 ordered the construction of the Niviansk and Kamensky Iron works. Cast iron cannons and projectiles were manufactured at both these works. Many other Government works were afterwards created in various parts of the Urals. Peter the Great and his successors evinced great energy and solicitude in establishing a private mining industry and thanks to the measures taken by the Government, nearly all the works now existing in the Urals were created within the space of a few decades. The most active helper of Peter the Great in establishing the metallurgical industry was William de Hennin, a native of Nassau, who from 1722 to 1734 was the head of the Siberian and Ural works, and erected many others. His predecessor and successor Tatischev also did much for the mining industry of Russia.

In speaking of the private mining industry of the Urals it would be impossible to avoid mentioning the active work done by Nikita Demidov, formerly a blacksmith of Tula. He was known personally to Peter the Great, who gave over the Niviansk works to his charge under the condition that Demidov should make cannons, mortars, cold arms, as well as manufactured iron and wire at these works. Thanks to his unusual

perseverance Nikita Demidov erected four more works in the Urals; indeed, he and his descendants built altogether thirty works in the Urals.

At the close of the sixteenth and beginning of the seventeenth centuries Russia was supplied with iron from Sweden, whence it was imported by Dutch merchants through the port of Archangel. The high price of this metal, induced one Vinius, a Dutch merchant settled in Russia, to erect works at Tula, for casting objects of iron and for manufacturing iron by the foreign method. He was granted permission to do this in 1632 by the Tsar Michael Fedorovich. Vinius erected four works on the banks of the river Toulitsa. He was subsequently joined by two other foreigners, who erected several new works in the governments of central Russia. It was also at Tula that Peter the Great became acquainted in 1696 with the blacksmith Nikita Demidov Antoufiev, from whom the family of the Demidovs descended, and who attracted the Emperor by his talent, skill and rare perseverance. Nikita Demidov rendered immense service in the development of the mining industries, of not only central Russia, but also of the Urals and Siberia.

Iron ores were first discovered in the government of Olonets in 1670 and their exploitation was soon given to Butenant von Rosenbusch a native of Denmark under the condition that he should furnish the Government with cannons and projectiles manufactured at the Petrovsk works erected in 1678. These works were subsequently taken over by the Government and their direction handed over to De Hennin who with the aid of foreign foremen introduced the manufacture of steel, sheet iron, anchors, wire and nails at these works and also placed them in a position to satisfy the requirements of the navy.

The Government, actively following up the idea of developing the production of iron in Russia with mineral fuel, has constantly held in view the establishment of independent iron works in the south of Russia, where both the pig iron and manufactured iron, transported from the Urals at a distance of two thousand versts, became so dear that it hindered and injured the industries and especially the agricultural interests of the district. From the very foundation of the Lougansk works in the government of Ekaterinoslav in 1797 up to the thirties of the present century experiments were made upon smelting pig iron from local ores and coal which, however, for various reasons were unsuccessful. Likewise, the works erected in Kertch in 1845 for the purpose of smelting local ores with anthracite from the Don basin also failed to give good results.

Experiments were then again carried on in the Donets basin and the Petrovsk iron works erected there in 1859. The Lisichansk iron works were then completed in 1870 and after the failure attending the Petrovsk works the experiments were transferred to these works. Here again the results were not satisfactory. Thus the repeated endeavours of the Russian Government to establish the manufacture of pig iron with local mineral fuel in the south of Russia remained unsuccessful. The honour of having attained success in this matter is due to John Hughs, a native of England and to a Russian capitalist named Pastoukhov. John Hughs, formerly chief foreman at the Millwal Iron works, London, signed a contract with the Russian Government in 1869, and having obtained large orders for rails at a high price, he agreed to erect a blast furnace capable of turning out two hundred tons of pig iron a week and to lay out a mine which would give two thousand tons of coal per day. In April, 1871, the first blast furnace was

blown in, a second was erected in 1876 and at the present time these works possess five furnaces and produce six million pouds of pig iron, one million pouds of iron, and three million pouds of steel and rails annually. Mr. Pastoukhov began to erect iron works in the Don province almost simultaneously with Hughs. These works manufacture pig iron with the local anthracite and the first pig iron was obtained during the autumn of 1872, but for various reasons the production of these works has not been as great as could be desired.

The discovery and detailed exploration of the extremely rich iron ore deposits of the Krivoi-Rog was followed by the establishment of several large enterprises in the south of Russia and the erection of vast iron and steel works. The first pioneers in this direction have found many followers and it may be confidently expected that in a short space of time the iron industry of the south of Russia will be developed to such a vast extent that the Ural works, after having existed over a hundred and fifty years, will be obliged to cede their precedence.

In the last partition of Poland, the land on which the iron industry first arose in the thirteenth century, was divided between Prussia, Austria and Russia. In 1814 there were forty-six blast furnaces within the limits of the then Principality of Warsaw. The period between 1833 and 1837 was remarkable for the introduction of the hot blast puddling process and the employment of coal in the manufacture of iron. The iron industry of Poland made particular progress about twelve years ago when large iron and steel works were erected by foreign capitalists.

The production of pig iron in Russia during the last ten years is given in the following table.

Production in pouds.

Years.	Iron works.									
			Private.							
	Government.	His Majesty's Cabinet.	Urals.	Central Russia.	South and south-west Russia.	Siberia.	Poland.	North Russia.	Finland.	Total.
1881	3,655,386	20,200	15,936,756	3,387,296	1,583,244	234,521	2,552,289	—	1,282,028	28,661,720
1882	3,238,454	89,045	15,661,347	3,320,911	2,004,734	291,231	2,366,345	—	1,264,960	28,237,027
1883	3,497,423	67,157	16,623,412	3,418,182	1,988,106	304,843	2,494,279	—	1,013,529	29,406,931
1884	3,379,391	148,320	17,879,919	3,661,955	2,031,119	335,469	2,356,926	—	1,312,513	31,105,612
1885	3,658,791	136,977	18,366,401	3,648,661	2,242,720	287,210	2,466,892	—	1,397,852	32,205,504
1886	3,451,291	192,839	17,806,958	3,991,857	3,077,503	226,357	2,831,690	—	905,922	32,484,417
1887	3,395,819	177,941	20,362,807	4,374,064	4,158,431	223,587	3,717,500	—	979,122	37,389,271
1888	3,789,384	102,799	20,648,906	4,605,724	5,432,681	192,301	4,782,570	—	1,161,311	40,715,676
1889	3,554,119	135,335	21,537,733	5,107,640	8,468,005	177,217	5,380,901	—	819,355	45,180,305
1890	4,160,600	159,459	24,012,529	5,753,708	13,417,718	278,923	7,423,961	5,046	1,348,160	56,560,074

The figures of this table show that altogether the production of pig iron in Russia has almost doubled during the last ten years. Taking the separate districts it is seen that the Ural private works have increased their production by fifty per cent, the works of Central Russia, by seventy per cent. The production of South Russia has

increased by eight and one-half times and of Poland by almost three times. The extent to which the general aspect of the production of pig iron according to the chief centres has changed, is seen in the following comparison of relative production for 1881 and 1890.

Years.	Government works.	Private works.				
		Urals.	Central Russia.	South Russia.	Poland.	Finland.
	Percents.					
1881	12·5	55·5	11·8	5·5	9	4·4
1890	7·3	42·4	10·1	23·7	13	2·3

During the last ten years the production of manufactured iron has varied in the following manner.

Production in pouds.

Years.	Works.									
	Government.	His Majesty's Cabinet.	Private.							Total.
			Urals.	Central Russia.	Poland.	South and south-western Russia.	North Russia.	Siberia.	Finland.	
1881	772,581	16,982	10,374,322	2,016,704	1,399 165	568,965	1,655,577	150,449	884,454	17,839,199
1882	512,674	22,291	10,007,083	2,744,010	1,518,423	670,695	1,519,925	155,827	1,000,882	18,151,810
1883	725,093	14,453	10,657,622	2,670,890	1,995,961	423,050	1,983,484	140,049	1,096,692	19,707,294
1884	934,743	44,199	11,244,379	2,768,228	3,498,644	616,086	1,717,606	163,644	1,126,637	22,114,166
1885	988,856	64.469	11,143,933	2,097,471	4,197,263	761,761	1,537,847	152,932	1,172,752	22,117,284
1886	872,359	77,264	11,445,827	1,651,693	4,585,844	857,600	1,917,332	142,752	610,677	22,161,348
1887	1,122,896	51,285	12,285,738	1,844,841	3,809,071	794,674	2,073,891	104,030	463,376	22,551,902
1888	1,006,492	71,244	12,481,214	2,234,780	3,238,640	1,001,027	1,601,568	114,733	505,634	22,255,332
1889	1,282,475	77,578	13,701,259	2,692,992	4,051,359	1,501,301	2,208,120	111,576	489,719	26,116,379
1890	1,187,718	91,176	13,654,191	3,082,641	4,137,237	1,578,700	1,792,526	173,626	747,730	26,445,545

The total production was divided in the following manner according to the sorts of iron.

Years.	Bar and assorted iron.	Sheet and roofing iron.	Boiler and armour plate iron.
	Pounds.		
1882	13.308,823	4,110,417	732,570
1883	14,713,281	4,467,366	524,147
1884	15,425,533	5,782,249	906,384
1885	16,095,299	4,944,559	1,077,426
1886	15,198,885	5,621,607	1,119,460
1887	15,706,551	5,611,496	1,233,855
1888	15,909,589	5,009,867	1,302,621
1889	18,037,914	5,897,354	1,392,808
1890	17,861,647	5,765,106	1,449,255

At the present day iron and steel are so often applied to one and the same purpose, and steel has in so many cases replaced iron that the one cannot be spoken of without mentioning the other, and therefore the production of steel in Russia during the last ten years may now be considered.

Production of steel in pouds.

Years.	Works.									
	Government.	His Majesty's Cabinet.	Private.							Total.
			Urals.	Central Russia.	Poland.	South Russia.	North Russia.	Siberia.	Finland.	
1881	163,420	501	1,826,374	3,575,129	3,902,267	1,266,748	7,146,558	—	26,383	17,907,380
1882	323,808	500	1,186,022	3,281,549	3,319,163	1,467,810	5,524,739	640	16,011	15,120,242
1883	178,510	504	1,588,717	3,023,410	3,434,834	1,118,963	4,183,340	1,078	16,628	13,545,984
1884	245,415	502	2,122,107	2,234,153	3,428,350	1,294,695	3,223,395	—	86,580	12,635,197
1885	220,173	252	1,915,600	1,524,699	2,446,012	1,955,757	3,493,899	2,337	217,548	11,776,277
1886	266,854	253	2,049,591	1,778,420	3,151,567	2,815,518	4,521,306	187	177,633	14,761,329
1887	325,255	253	2,002,976	2,265,864	3,048,327	2,488,743	3,509,711	187	125,021	13,765,537
1888	279,514	—	2,121,590	2,445,130	3,137,227	2,405,381	3,102,735	790	78,368	13,570,735
1889	442,475	—	2,140,808	4,014,386	2,390,407	3,721,399	3,026,232	1,415	58,630	15,795,752
1890	371,783	—	2,344,455	5,248,589	3,365,673	7,043,547	4,577,338	1,250	150,162	23,102,797

Data respecting the production of steel of various kinds can only be given for the last three years, as below.

Years.	Production of steel in pouds.				
	Cementation steel.	Puddled steel.	Bessemer steel.	Marten steel.	Crucible steel.
1888	118,754	145,587	3,125,100	9,921,113	260,181
1889	107,888	223,185	4,863,780	10,298,453	302,446
1890	88,293	26,265	7,221,428	15,436,034	330,777

And lastly the following table gives the production of steel rails and of sheet and assorted steel during the last ten years.

Years.	Steel rails.	Assorted steel.	Sheet steel.
1881	12,611,872	93,911	198,398
1882	9,356,805	432,939	342,726
1883	7,854,875	865,019	432,352
1884	5,998,617	1,103,833	372,342
1885	5,831,669	1,405,643	234,226
1886	6,959,742	1,142,940	562,832
1887	5,309,672	2,034,839	1,365,754
1888	3,847,945	1,221,265	1,290,559
1889	5,394,338	2,948,669	983,346
1890	10,140,874	3,833,626	1,276,353

The total production of iron and steel taken together has increased by 38·6 per cent since 1881. Taking the different iron-producing regions separately the following changes in the production during the last ten years may be deduced: that of the Government works has increased by 65 per cent; of the Ural private works, by 31 per cent; of Central Russia, by 50 per cent and of Poland, by 41 per cent. In South Russia the production of iron and steel has increased nearly fivefold, while that of the works of northern Russia has fallen about 25 per cent.

The production of different sorts of iron and steel has gradually and somewhat uniformly risen. The manufacture of steel rails has been subject to great fluctuations owing to their demand depending upon the erection of new and the re-equipment of the already existing railroads.

The manufacture of rails in the Empire has its history. When Russia first began constructing its railroads the Government made every endeavour to encourage the manufacture of rails by private individuals. When the Chief Company of Russian Railroads was instituted, about 1855, the Russian iron-masters were invited to supply the necessary rails, but only four works in the Urals appeared in answer to the invitation, and only two of these took the matter in hand, supplying 3,250,000 pouds of iron rails between 1856 and 1860, after which they refused to manufacture more. Since then certain works have undertaken orders for the manufacture of small parcels of rails. In the mean time the Poutilov works near St. Petersburg started turning over old iron rails and giving them steel heads.

The importance of the production of rails to Russia, will be better understood by showing the gradual progress of the construction of railroads in the Empire, Finland excluded.

In 1838 . . .	— 25 versts.	In 1875 . . .	— 17,718 versts.
» 1850 . . .	— 468 »	» 1880 . . .	— 21,226 »
» 1860 . . .	— 1,490 »	» 1885 . . .	— 24,258 »
» 1865 . . .	— 3,577 »	» 1890 . . .	— 28,581 »
» 1870 . . .	— 10,090 »	» 1892 . . .	— 29,156 »

In 1866 a project was made for the erection of large rail-rolling works in the south of Russia, but Mr. Reitern, then Minister of Finance, expressed the opinion that it was impossible to stop the construction of railroads indispensable to Russia until the rail-rolling industry, then in its infancy, could be sufficiently developed. It was, therefore, decided to encourage reliable private companies to erect rail-rolling mills in the south of Russia, but not to stay the construction of railroads. As the above data show, the construction of railways was most energetically carried out between 1868 and 1878 and during these years over ninety million pouds of iron and steel rails were imported at a cost of over a hundred and fifty million roubles.

It was during this period that John Hughs in 1873 started the production of rails in the south of Russia. In 1874 the Briansk rail-rolling works erected by Messrs. Goubonin and Goloubev in the government of Oriol, began working, and lastly in 1875 the Nizhni-Saldinsk works of Prince Demidov San Donato, were the first to start the manufacture of steel rails in Russia. In 1875 the manufacture of rails was revolutionized, owing to the generally recognised necessity of changing iron for steel rails.

In 1876, because of the constantly increasing importation of foreign rails, the Russian Government found itself obliged to issue a series of measures, which were adopted in

view of the development of the home-rail production. These measures were the following: 1. the institution of a poudage bounty on the manufacture of steel rails, by independent works, from Russian pig iron and by iron works using old rails; 2. the issue of Government orders for fifteen million pouds of rails; 3. the prohibition of the free importation of rails.

The result of these measures was that the three already existing rail-rolling works were rendered capable of making steel rails, and furthermore, four more steel rail-rolling works were erected in various parts of Russia, so that counting the Demidov works in the Urals, which had been previously capable of turning out steel rails, there were at that time altogether eight rail works in the Empire.

The following table gives the number of workmen employed in the iron industry, that is, in iron mines and works, during the last five years.

	1886.	1887.	1888.	1889.	1890.
In the Urals.	145,910	174,018	177,188	158,486	165,057
» Central Russia	21,187	20,183	19,954	21,858	25,754
» Poland.	11,021	10,341	12,234	12,460	11,376
» South and south-west Russia	5,956	6,603	9,260	10,294	15,698
» North Russia.	9,382	9,254	7,028	8,481	10,652
» Siberia.	2,380	1,814	1,933	2,422	1,930
» Finland	1,652	2,524	3,162	2,636	3,177
Total	197,488	224,737	230,759	216,637	233,644

On comparing this table with that showing the production of the different regions, it is seen that the number of workmen employed is comparatively very high in those regions where the smelting of pig iron and the manufacture of iron and steel is exclusively carried on with charcoal. This is due to the preparation of charcoal, the cutting of the wood inevitably requiring a considerable expenditure of manual labour.

Internal iron trade.

The iron and steel works of the Urals as the most important sources of iron and steel are now connected on the southern side only by an uninterrupted railway line with the general railway system of the Empire; but on the other hand they enjoy an exceedingly vast system of water communication transporting their produce along the rivers Chusovaia, Belaia and Viatka to the Kama and thence to the Volga. This cheap route, as much as two thousand versts long, opens out an immense market to the iron industry of the Urals, the entire length of the Volga, the Transcaspian provinces and Persia and with the canals, there is also access to the White, Baltic and Azov seas. However, the advantages of this route are limited by the fact that it is only practicable for six or seven months in the year, so that during the rest of the year the majority of the Ural works have no communication with the consumers of their produce and are obliged to keep a large amount of capital idle, without returns.

The position of the three other chief centres of the Russian iron trade, namely Poland, Central and South Russia, is much more propitious in this respect, owing to their being in connection with the general railway system of the Empire, and to their proximity to the consuming markets. The chief market for the Urals is that of Nizhni-Novgorod to which are sent from seven to eight million pouds of iron product every year. The other chief markets for pig iron and manufactured iron, are St. Petersburg, Moscow, Warsaw, Odessa, Riga and Rostov-on-Don. These towns obtain their iron and steel from one or other of the iron centres, according to their proximity or convenience of transport.

The external iron and steel trade and the fiscal regime to which it is subjected, play an exceedingly important part in the economical condition of Russia.

In the middle of the past century Russian iron formed one of the chief articles of export, and in 1782, amounted to 3,840,000 pouds, to the value of more than five million roubles. At the close of the last century Great Britain alone imported annually about two million pouds of iron from Russia; but at the beginning of the present century the export decreased, owing to the development of iron works in other countries, especially in England. Up to 1862 Russia was able to satisfy its internal demand for pig iron, iron and steel by its own product; but since 1863 the demand for iron has increased, chiefly owing to the active construction of railroads, and this together with the small progress made by the home production has resulted in a rapid increase in the importation of foreign iron.

Up to 1857 the Government held a prohibitory system with regard to the importation of iron and steel; but the prohibition against the importation by sea, with the exception of the ports of the Sea of Azov, of pig iron and manufactured iron was rescinded by the customs tariff of 1857, and a duty of 15 kopecks a poud was put upon pig iron and of 50 to 90 kopecks upon iron. However, in 1859 these duties were lowered to 5 kopecks upon pig iron and 35 kopecks upon bar, scrap iron and rails, 45 kopecks upon manufactured iron and 75 kopecks upon boiler plate, retort, sheet and armour plate. The duty upon steel was then 70 kopecks a poud. In 1868 the duty on pig iron remained unchanged, but that on bars, scrap and assorted iron was altered to 36 kopecks; sheet, boiler plate, armour plate and retort iron, to 50 kopecks; rails, to 20 kopecks; and steel, to 80 kopecks. The prohibition against the importation of pig and manufactured iron by the ports of the Azov was also abolished at the same time.

The lowering of the import duties upon iron coincided with a considerable animation in the construction of railroads, and therefore the importation of iron rose rapidly, and in 1870 amounted to over eighteen million pouds, that is, two and one-half million pouds above the production at home. The general application of steel in the place of iron rails, induced the Government in 1871 to lower the duty upon steel rails to 45 kopecks per poud instead of 80 kopecks to which they were previously subjected as steel goods.

Starting from 1881 the duties upon pig iron, iron and steel were gradually raised in order to protect the home industry. Thus, in 1884 a progressively rising duty upon pig iron was instituted for a period of three years, thus, from June 1, 1884, to March 1, 1885, the duty upon pig iron, imported by land or sea, was 9 kopecks, from March 1, 1885, to March 1, 1886, 12 kopecks, and from March 1, 1886, the duty was 15 kopecks in gold per poud. In 1887 this duty was again increased, as follows: for pig iron imported by sea, to 25 kopecks per poud, and for pig iron imported by land, to 30 kopecks in gold per poud.

The duties upon iron and steel were also gradually raised in 1881, 1882, 1885 and 1887. Those instituted in 1887 were as follows: a. bar and assorted iron, blooms, puddled ingots or mill bars, steel bars and ingots, and all kinds of assorted steel, 50 kopecks in gold per poud; b. iron and steel rails, 50 kopecks in gold per poud; c. sheet and plate iron and sheet and plate steel over 18 inches wide, and assorted iron and steel over 18 inches wide or high, or having a diameter of 7 inches and above, as well as fine assorted iron and steel from one-quarter to one-half of an inch inclusive in diameter or width, 70 kopecks in gold per poud; d. iron one-quarter of an inch and less in diameter or width is counted as wire and pays a duty of 1 rouble 10 kopecks in gold per poud.

The following tables give the amount of pig iron, iron and steel imported into Russia during the years from 1881 to 1890.

Importation of Pig iron.

Years.	Importation of pig iron.	Years.	Importation of pig iron.
1881	14,293,000	1886	16,178,802
1882	13,363,000	1887	7,877,613
1883	14,491,000	1888	4,590,877
1884	17,330,000	1889	7,132,890
1885	13,509,000	1890	7,712,600

Importation of iron of various sorts.

Years.	Bar, scrap and assorted iron.	Sheet iron, boiler and plate iron.	Iron rails.	Total.
	P	o u	d	s.
1881	4,633,000	1,853,000	58,000	6,544,000
1882	4,573,000	2,136,000	55,000	6,764,000
1883	3,702,000	2,770,000	39,000	6,511,000
1884	2,660,000	2,211,000	11,000	4,882,000
1885	2,250,000	1,628,000	37,000	3,915,000
1886	3,358,221	1,400,073	22,727	4,781,021
1887	2,206,173	1,164,697	6,386	3,377,256
1888	2,616,671	1,396,745	11,711	4,025,127
1889	3,372,975	1,880,554	29,846	5,283,375
1890	3,825,598	2,008,262	46,625	5,880,485

Importation of steel of various sorts.

Years.	Bar, scrap and assorted steel.	Sheet and plate steel.	Steel rails.	Total.
	P	o u	d	s.
1881	540,000	90,000	820,000	1,450,000
1882	262,000	19,000	286,000	567,000
1883	194,000	37,000	79,000	310,000
1884	263,000	75,000	133,000	471,000
1885	211,000	57,000	125,000	393,000
1886	525,449	140,364	43,854	709,667
1887	309,291	140,426	17,559	467,276
1888	458,666	120,241	13,169	592,076
1889	742,023	163,535	73,161	978,719
1890	767,494	153,603	103,419	1,024,516

Although up to 1877 the importation of pig iron into Russia did not exceed three million pouds a year, yet in 1878 it began rapidly to increase. This was partly due to the erection of large rail-rolling works, and partly to the erection of works near the frontiers for converting foreign pig into manufactured iron, taking advantage of the difference in the duties upon the two products. However, due to the raising of the duty upon iron partly because of the erection of the above-mentioned works and partly because of the development of the home production, the importation of these metals, which for the five years ending 1878 was about eighteen million pouds a year, began to fall considerably. Besides the above-mentioned iron goods, Russia imports a considerable quantity of tin plate. In 1888 the importation of tin plate amounted to 964,000 pouds, in 1889, to 1,076,000 pouds, and in 1890, to 1,490,000 pouds. This tin plate is almost exclusively imported via Batoum, where it is passed free of duty for the requirements of the local tin case factories making tin cases for transporting the naphtha products abroad. The importation of iron and steel wire during the last five years, 1886 to 1890, has been somewhat constant, varying between twenty-four and thirty-three thousand pouds a year.

The importation of iron and steel from Russia is very small. Still the famous Russian sheet iron and certain other kinds find a market abroad. The following table gives the exports of iron from Russia.

Years.	Sheet.	Scrap.	Other kinds.	Pouds.
	Pouds.			
1881	120,300	191,400		311,700
1882	97,000	257,200		354,200
1883	181,600	120,900		302,500
1884	144,700	160,700		305,400
1885	134,500	96,400	119,700	350,600
1886	124,100	108,300	209,000	441,400
1887	94,400	143,600	124,700	362,700
1888	47,600	60,900	104,700	213,200
1889	60,600	125,900	127,400	313,900
1890	84,700	106,600	114,000	305,300

Although Russian sheet iron goes almost exclusively to the foreign markets of Great Britain, Germany and America, the manufactured iron and iron scrap goes chiefly to Persia.

The following three tables show which countries chiefly participate in supplying Russia with pig iron, iron and steel.

Countries.	Pig iron and pig iron scrap.		
	1888.	1889.	1890.
	Pouds.		
From Great Britain.	3,114,000	4,663,800	5,212,800
» Germany.	817,200	1,673,800	1,326,500
» Holland	97,800	233,300	220,100
» Belgium	5,800	207,300	111,900
» Sweden	160,400	86,500	110,700
» Austro-Hungary.	152,700	—	98,300
» United States.	—	—	83,800
» Norway	—	—	6,300
» France.	—	—	1,500

Countries.	Bar iron, scrap and assorted iron.			Sheet iron, boiler plate and plate iron.			Iron rails.		
	1888.	1889.	1890.	1888.	1889.	1890.	1888.	1889.	1890.
	Pounds.								
From Germany	1,225,500	1,340,000	1,501,700	441,900	637,100	816,300	8,100	9,400	28,300
» Belgium	392,500	992,800	740,000	240,800	557,000	338,000	600	19,800	5,300
» Great Britain	347,900	400,000	364,200	634,200	572,300	711,400	2,800		10,400
» Sweden	100,200	155,100	296,000	8,100	12,600	11,300	—	—	—
» Austro-Hungary	90,400	89,900	218,500	4,300	12,300	51,900	—	—	1,200
» Holland	44,200	83,400	202,100	45,900	75,500	65,100	—	650	—
» Denmark	2,500	9,900	5,500	3,400	—	1,400	—	—	—
» France	—	—	800	650	3,900	6,000	—	—	-
» Italy	1,200	—	—	—	—	—	—	—	—
» United States	—	2,900	—	—	—	—	—	—	—

Countries.	Steel in bars, scrap and assorted steel.			Steel in sheets and plates.			Steel rails.		
	1888.	1889.	1890.	1888.	1889.	1890.	1888.	1889.	1890.
	Pounds.								
From Germany	208,300	405,000	296,000	70,900	61,200	49,600	700	12,500	19,400
» Belgium	21,600	52,400	234,300	6,700	15,300	14,500	5,000	44,500	65,200
» Great Britain	130,900	195,600	148,600	41,500	78,400	68,000	—	1,000	3,600
» Sweden	11,350	13,400	38,200	—	2,350	—	—	—	—
» Holland	78,700	41,800	29,500	500	2,500	16,000	—	—	—
» Austro-Hungary	5,600	16,100	15,400	—	3,400	4,600	—	—	300
» Turkey	—	1,850	1,500	—	—	—	—	—	—
» Italy	—	—	1,400	—	—	—	—	—	—
* » Denmark	—	1,000	700	—	—	—	—	—	—
» France	—	9,300	700	—	—	—	—	—	—

According to the customs tariff of 1891 the following duties were laid on iron and steel.

Paragraph 139; cast iron in pigs, scrap and turnings:

I. All kinds except those especially indicated:

a. Imported by sea, 30 kopecks per poud.

b. Imported by land across the western frontier, 35 kopecks per poud.

II. Ferro-manganese, spiegeleisen, silico iron and chrome iron alloys, 50 kopecks per poud.

Remark: These duties are not subject to alteration before January 1, 1898.

Paragraph 140; I. Bar and all kinds of manufactured iron, except those mentioned below, iron blooms, puddled iron, pieces or ingots, scrap, mill bars, iron powder, 60 kopecks per poud.

II. Iron rails, even if drilled or grooved, 60 kopecks per poud.

III. Sheet iron up to number 25, according to the Birmingham calibre, iron plates over 18 inches wide, all kinds of manufactured iron over 18 inches wide or high, or over 7 inches thick or in diameter, fashioned iron, such as branded, double-branded girders, cross beams and such like, complex profile, except angle iron, which belongs to clause I, manufactured iron of finer calibre, between one-quarter and one-half of an inch in width or diameter, 85 kopecks per poud.

IV. Sheet iron over № 25, according to the Birmingham calibre, 1 rouble per poud.

Remark: Iron less than one-quarter of an inch thick or in diameter pays duty according to paragraph 155, clause 1.

Paragraph 141; Tin plate, polished, stamped with designs, and damascened; sheet iron coloured, polished, coated with zinc, copper, nickel and other metals, 1.70 roubles per poud.

Paragraph 142; steel.

1. Bar and manufactured steel of all sorts, except those specially mentioned below, steel ingots, steel scrap, 60 kopecks per poud.

2. Steel rails, even if drilled or grooved, 60 kopecks per poud.

3. Sheet steel of all kinds up to № 25, according to the Birmingham guage, steel plates over 18 inches wide, all kinds of manufactured steel over 18 inches wide or high and 7 inches in thickness or diameter. Fashioned steel, branded, double-branded girders and cross beams and of other like complex profile, except steel angle, which comes under paragraph 1, fine assorted steel from one-quarter to one-half of an inch in width or diameter inclusive, 85 kopecks per poud.

4. Sheet steel above № 25, according to the Birmingham guage, 1 rouble per poud.

Remark: Steel one-quarter of an inch and less in width or diameter comes under paragraph 155, clause 1.

Paragraph 155; wire.

1. Iron and steel wire.

a. From one-quarter of an inch in width or diameter to № 25, B. G. inclusive, 1 rouble per poud.

b. Above № 25 to № 29 inclusive, 1·50 roubles per poud.

c. Finer than № 29, 2 roubles per poud.

Remark: All wire, coated with tin, zinc or other metals, pays an additional duty of 50 per cent above that to which its guage corresponds.

Coal.

Although coal veins had been known to exist in various parts of European and Asiatic Russia since the last and the beginning of the present century, still up to about 1855, coal was only worked in the south of Russia and Poland, and then the total yield did not even attain ten million pouds. The Government, however, made every endeavour to raise a regular coal industry not only in the Donets and Polish coal fields, but also in central Russia, the Urals, Caucasus and on the island of Sakhalin.

It is impossible not to call attention to the fact that the position of the chief Russian coal fields coincides with other important economical conditions which give a still greater importance to the Russian coal industry [1].

The coal fields of central Russia, known as the Pod-Moscow Coal Basin, are situated on the spot occupied by the oldest and most flourishing manufacturing district. The Donets coal fields are situated in a district perfectly void of forests, and coal is the only fuel for satisfying the wants of the inhabitants and of the railroads for any length of time. The proximity of extremely rich deposits of iron ore gives the right to count upon the development of a vast coal trade in the south of Russia, while the near neighbourhood of the sea gives the possibility of a wide market to this coal. The Ural coal fields coincide with an abundance of mineral wealth which has long been known and valued by the savants of all Europe.

The Kiev-Elisavetgrad coal field is situated in the centre of the sugar industry which alone furnishes a considerable demand for coal; this field gives a brown coal. In western Siberia the Kusnetsk coal basin occurs in the Altai mining district, which is known for the richness of its ore deposits. The coal veins of the Kirghiz steppes will be of great importance in the future when the metallurgical industries are more developed in this forestless district rich in copper, silver and lead ores. In eastern Siberia the coal veins of the island of Sakhalin and those recently discovered on the river Soukhanov give an excellent coal, and guarantee the Russian fleet and merchant vessels on the Pacific ocean a supply of fuel.

In Western Europe and America the largest manufacturing centres have been established and developed to enormous dimensions on their present sites, due solely to the production of coal from veins occurring in the nearest proximity. In Russia on the contrary a demand for combustible material in localities rich in coal existed and grew before the rise of the coal industry. The only exception was Poland where the manufacturing industries acquired their present status chiefly owing to the abundance and cheapness of coal.

An outline of the position of the coal industry in various parts of Rnssia is given below, and the following table shows the gradual progress made during the last thirty-five years.

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[1] See map of the Russian coal fields.

Years.	Coal fields.										Total.
	Donets.	Poland.	Pod-Moscow.	Ural.	Kiev-Elisavetgrad.	Caucasus.	Kirghiz stepps.	Kusnetsk.	Island of Sakhalin.	Turkestan.	
	Pouds.										
1855	4,500,000	4,454,000	—	440,000	—	100,000	—	—	—	—	9,494,000
1860	6,009,000	10,788,000	631,000	408,000	—	100,000	185,000	55,000	133,000	—	18,309,000
1865	9,829,000	10,743,000	1,371,000	766,000	—	145,000	202,000	267,000	8,000	—	23,331,000
1870	15,647,000	20,079,000	5,078,500	387,000	—	198,000	478,000	350,000	123,000	75,000	42,416,500
1875	51,437,000	24,904,000	23,659,000	1,279,000	1,093,000	377,000	832,000	256,000	96,000	415,000	104,348,000
1880	86,347,000	78,449,000	25,118,000	7,217,000	534,000	387,000	1,240,000	485,000	502,000	305,000	200,784,000*
1885	114,946,000	109,282,000	21,307,500	10,875,000	555,000	213,000	1,636,000	795,000	550,000	417,500	260,577,500
1890	183,249,000	150,792,500	14,268,000	15,224,000	693,000	605,000	127,000	1,051,500	892,500	301,000	367,203,500

* In 1890, 200,000 pouds of anthracite were raised at Olonets.

The figures of this table clearly indicate the situation of the coal industry in the different fields during the last thirty-five years. Notwithstanding the rapid growth of the yield of coal in Russia the home production cannot satisfy the large and yearly increasing demand, and hence a considerable quantity is imported. The total amount of coal now consumed in Russia amounts to 460 million pouds annually, which with a population of 117 million amounts per year to about four pouds per capita. Exact data respecting the consumption of coal only exist for the railroads, and the following table shows the gradual growth of their demand.

Years.	Consumption of coal.		
	Russian.	Foreign.	Total.
	Pouds.		
1875	—	—	30,424,800
1880	54,691,300	17,513,300	72,204,600
1885	66,721,000	8,813,800	75,534,800
1890	68,538,700	6,898,900	75,437,600

It is interesting to follow the growth of the consumption of Russian coal from the different fields by the Russian railroads. This may be seen in the following table giving the data for the last ten years:

	1880.	1885.	1890.
	Pouds.		
Anthracite, Don coal fields	10,878,800	7,099,600	5,121,100
Don coal fields	22,239,600	34,332,800	39,762,600
Pod-Moscow	10,256,900	8,602,000	5,410,900
Poland	10,815,500	13,773,800	17,556,600
Urals	108,566	2,912,500	5,786,200
Caucasus	363,587	200	22,500

This table shows a rapid growth in the consumption of coal from the Don, Polish and Ural coal fields, and a reduction of one-half in the consumption of coal and anthracite from the Pod-Moscow basin.

The total consumption of coal in Russia has been approximately determined to be as follows:

	Pouds.
Metallurgical and metal industry	120,000,000
Railroads	76,000,000
Navy and other vessels	25,000,000
Gas works	15,000,000
Manufacture of textile fabrics	40,000,000
Sugar works	35,000,000
Other industries	80,000,000
Coal and other mines, salt works	15,000,000
House-warming and other purposes	55,000,000

The following two tables show: 1. the number of mines worked and the number of shafts in action; 2. the number of steam engines and their horse powers employed in the coal mines of the different coal fields during the last five years.

Coal fields.	1886.		1887.		1888.		1889.		1890.	
	Number of mines.	Number of shafts.	Number of mines.	Number of shafts.	Number of mines.	Number of shafts.	Number of mines.	Number of shafts.	Number of mines.	Number of shafts.
Don	257	760	244	699	263	914	270	777	270	763
Polish	27	54	27	58	20	56	20	59	20	52
Pod-Moscow	10	34	10	56	12	39	12	36	12	46
Ural	5	14	6	17	7	20	8	21	8	19
Kirghiz steppes	2	4	5	16	8	13	9	37	8	24
Kievo-Elisavetgrad	1	3	4	5	7	3 / 7	1	3	1	3
Sakhalin	1	3	1	3	1	3	1	3	1	3
Kusnetsk	2	6	2	6	2	6	2	6	2	7
Caucasus	2	4	5	16	8	13	8	31	7	20
Turkestan	3	5	5	2 / 3	6	8	5	9	6	12
Total	310	887	309	881	327	1,082	337	982	336	949

Coal fields.	1886.		1887.		1888.		1889.		1890.	
	Steam engines.	H. P.	Steam engines.	H. P.	Steam engines.	H. P.	Steam engines.	H. P.	Steam engines.	H. P.
Don	148	3,352	158	3,553	186	4,038	221	5,171	228	5,856
Polish	139	8,643	149	9,226	155	9,971	167	9,898	167	10,497
Pod-Moscow	54	664	33	470	35	526	36	521	34	594
Ural	—6	100	5	91	5	91	8	161	9	241
Kirghiz steppes	—1	12	1	6	1	6	—	—	3	14
Kievo-Elisavetgrad	—	—	1	10	1	10	1	10	1	10
Sakhalin	—	—	—	—	—	—	—	—	—	—
Kusnetsk	1	14	1	14	1	14	1	14	2	19
Caucasus	—	—	—	—	—	—	—	—	—	—
Turkestan	—	—	—	—	—	—	—	—	—	—
Total	349	12,785	348	13,373	384	14,656	434	15,775	444	17,231

The accompanying table gives the number of men employed underground and at the mouths of the shafts in the different coal fields during the last three years.

Coal fields.	1888.			1889.			1890.		
	Underground.	Surface.	Total.	Underground.	Surface.	Total.	Underground.	Surface.	Total.
Don	16,423	4,047	20,470	20,963	4,704	25,667	—	—	25,167
Polish	7,274	2,868	10,142	7,244	2,851	10,095	6,077	2,615	8,692
Pod-Moscow	1,915	1,007	2,922	2,141	988	3,129	1,733	719	2,452
Ural	1,284	1,427	2,711	1,713	1,223	2,936	1,176	1,250	2,426
Kirghiz steppes	206	—	206	202	—	202	125	22	147
Kievo-Elisavetgrad.	85	—	85	40	13	53	21	7	28
Sakhalin	212	386	598	228	242	470	277	236	513
Kusnetsk	235	107	342	219	219	438	207	403	610
Caucasus	178	24	202	102	14	116	206	164	370
Turkestan	195	84	279	108	57	165	86	73	162
Total	28,007	9,950	37,957	32,960	10,311	43,271	—	—	40,571

If a comparison be made of the figures of these three tables and the production of coal in the different coal fields, it will immediately be seen that the Polish coal mines differ distinctly from the others in the vastness of their yield. As the Polish and Donets coal fields always very nearly equal each other in their yield a comparison will be made only of these two fields for the year 1890, when the yield of the former was 150,000,000 pouds, and of the latter, 183,000,000 pouds. The latter amount was furnished by 270 coal mines from 763 shafts, that is, each mine on the average yielded 678,000 pouds and each shaft 240,000 pouds. In Poland there were only 20 mines in work, with 52 shafts which gave a yield of 7,500,000 pouds from each mine, and 2,985,000 pouds from each shaft. Similarly a comparatively rare application of steam power is seen in the Donets coal fields where there were only 228 steam engines to 763 shafts, that is, less than one engine to three shafts, while in Poland there were 167 steam engines to 52 shafts, or more than three engines per shaft. And lastly with respect to the number of men employed, in the Polish mines the yield of coal per man is much greater than in the Donets district. This may also be ascribed to the larger application of steam power and to the thickness of the coal veins, which in the Donets coal fields rarely exceeds one sagene, while in Poland the chief vein, which gives nine-tenths of the entire production, is from four to six and more sagenes thick.

Passing now to the exportation and importation of coal it is seen that Russia, with an exceedingly limited export, receives a very considerable quantity from abroad, and that this importation is on the whole gradually increasing notwithstanding the growing home production. The following table shows the gradual progress of the Russian importation of coal.

Years.	Total importation of coal.	Average yearly importation of coal.
	Pouds.	
1866—1870	245,510,000	49,102,000
1871—1875	302,474,600	60,500,000
1876—1880	485,515,000	97,103,000
1881—1885	561,144,000	112,228,800
1886—1890	499,120,000	99,824,000

In this table the figures up to 1885 show the combined importation of coal and coke, but those for the past five years do not include coke. During these five years the importation of coke amounted to 49,334,500 pouds, or on the average, 9,867,000 pouds per year, so that the combined average importation of both coal and coke amounted to 109,691,000 pouds. As in Russia there are three chief regions of consumption, south Russia, Poland and the Baltic coasts, the first two of which being able to supply themselves with coal from the local coal fields, while the latter is necessarily obliged to consume foreign coal, it is important to know how the total importation of coal is distributed between these regions. During the last five years the distribution was as follows.

Importation.	1886.	1887.	1888.	1889.	1890.
	Pouds.				
	a. Coal.				
To White Sea ports	214,200	117,800	274,100	299,400	289,100
To Baltic ports	72,761,200	70,543,400	69,582,200	84,499,300	74,558,400
Across the western frontier	20,957,500	12,893,000	11,094,500	10,658,600	9,617,800
To Black Sea and Azov ports	13,080,000	3,322,400	15,095,300	18,416,100	9,478,500
Across Asiatic frontier	72,700	121,400	539,600	411,950	220,600
Total	107,085,600	86,998,000	96,585,700	114,285,350	94,164,400
	b. Coke.				
To White Sea ports	1,200	1,300	300	12,000	3,200
To Baltic ports	3,063,500	3,809,800	3,461,800	5,391,300	3,202,600
Across the western frontier	3,300,700	4,971,300	5,704,600	6,479,400	9,055,900
To Black Sea ports	34,400	—	625,100	140,600	27,000
Across Asiatic frontier	—	22,700	8,000	14,300	3,600
Total	6,399,800	8,805,100	9,799,800	12,037,600	12,292,300

While the importation of coal and coke through the Baltic ports remains nearly constant, that of both coal and coke to western Russia is subject to a considerable and at the same time somewhat constant variation. Although the importation of coal across the western frontier has fallen nearly one-half during the last five years owing to the growth of the production of the Polish coal fields yet the importation of coke has nearly tripled during the same period. This must be ascribed to the rapid growth of the production of pig iron in Poland for which coke is imported from Prussia and Austria, as

the Polish coal is non-coking. During the last five years the following countries were the chief exporters of coal to Russia.

Countries.	1886.	1887.	1888.	1889.	1890.
		Pounds.			
		a. Coal.			
Great Britain . . .	86,166,600	73,949,000	85,034,800	102,589,800	84,522,700
Germany	19,520,800	12,383,800	10,579,800	40,579,800	8,662,900
Austria	1,281,600	300,600	327,650	538,000	711,300
Norway and Sweden	—	271,600	450,400	492,200	21,100
Spain.	—	—	—	359,800	124,100
		b. Coke.			
Great Britain . . .	2,775,250	3,241,450	3,630,350	5,140,700	3,062,750
Germany	3,200,600	4,286,650	4,789,800	4,660,300	6,045,000
Austria	403,100	1,157,000	1,317,700	2,097,800	3,178,300
Holland.	20,850	78,100	54,000	138,900	—

The exportation of coal from Russia during the last five years is expressed by the following figures:

1886. . . .	150,000 pouds.
1887. . . .	192,000 »
1888. . . .	950,900 »
1889. . . .	880,900 »
1890. . . .	834,700 »

In order to protect the Russian coal industry from foreign competition during the last ten years the Government has found it necessary to place a duty upon foreign coal, and this duty has been gradually raised. Until the year 1884 all coal, with the exception of that passing through the Polish frontier, was imported free of duty. In 1882 the coal imported through the Polish frontier was subjected to a duty of one kopeck per poud instead of half a kopeck as before. In 1884 a duty was put upon the coal and coke imported through all the frontiers of Russia with the exception of the White Sea, namely: 1. the ports of Black Sea and Sea of Azov, 2 kopecks in gold per poud; 2. across the western frontier by land, one and one-half kopeck in gold per poud; 3. the ports of the Baltic, half a kopeck in gold per poud. In 1886 the duty upon coal imported through the ports of the Black Sea and Sea of Azov was raised to three kopecks; and in 1887 the duties upon coal and coke were distributed and altered as follows:

	Coal.	Coke.
Imported through ports of the Black Sea and Sea of Azov.	3 kopecks.	4½ kopecks.
Imported across the western frontier by land	2 »	3 »
Imported through ports of the Baltic.	1 »	1½ »

The customs tariff of 1891 did not introduce any changes in these duties, but in 1892 the duties on the coal and coke imported through the ports of the Black Sea and Sea of Azov were raised to four kopecks for coal, and six kopecks in gold for coke.

The Donets coal field.

This basin occupies the southern portion of the government of Kharkov, the eastern portion of the government of Ekaterinoslav and the western portion of the province of the Don Cossacks. It extends over an area of irregular form, lengthened in the direction from west to east, 320 versts long and 150 versts across. By its geological structure the whole area of the Donets coal field may be divided into three portions; the middle, and most extensive, consists entirely of strata of the carboniferous system; the eastern and western portions are covered by more recent strata amongst which those of the carboniferous system only appear in the form of separate islands. Surveys made in 1864 and 1869 showed that the carboniferous strata of the Donets basin cover an area of about 20,000 square versts. But it has been asserted by such authorities as Le Play, Helmersen and Guillaumen that the strata of the carboniferous system extend over an equal area beneath strata of the Permian, cretacious and tertiary systems, so that in all, the area occupied by the coal-bearing strata of the south of Russia may be taken as approximately forty thousand square versts. The superficial aspect of the district is hilly, intersected in different directions by deep ravines; on the average it is situated at an elevation of 460 feet above the level of the sea, although in many places it stands much higher.

The first record of the discovery of coal in the south of Russia belongs to the beginning of the eighteenth century at the time of Peter the Great's Azov campaign. A piece of coal was brought to the Emperor who being already acquainted with its use in Western Europe pronounced the famous words: "This mineral will be extremely valuable, if not to us, at all events to our descendants." At the close of the last century the Government endeavoured to apply the Donets coal to heating the Black sea fleet, and to transport it to the nearest ports. In 1797 the Lougansk Iron Works were built for satisfying the requirements of the Black sea fleet and to establish the manufacture of pig iron with local coal in the south of Russia. If these efforts were not crowned with success, at all events the surveys made between 1797 and 1806 brought many deposits of coal and iron ores to light, which subsequently aided the systematic investigation of the whole of the Donets coal basin.

One of the chief movers in starting the extraction of coal in the south of Russia was Count Vorontsov, then Govenor General of Novorossia and Bessarabia; and it was in his time that a geological survey of the Donets basin was begun. In 1827 Mr. E. Kovalevsky's report on the geological survey was published, and in it the Donets coal fields were for the first time called a vein, and its formation referred to the most ancient or carboniferous sandstone age. In 1835 scientific explorations of the coal veins were begun by mining engineers specially sent for the purpose by the Government. Soon afterwards a private individual appeared in aid of the Government, and in 1837 an expedition was sent by Anatole Demidov, to explore the mineral wealth of the south of Russia. In this expedition the Donets basin was explored by the French engineer Le Play, who in 1842 published his remarkable memoire on the Donets coal field, under the title "Voyage dans la Russie méridionale, par Le Play; Paris, 1842." In this memoire the strata of the Donets basin were for the first time scientifically classified into their

various systems. Le Play did not recognize the existence of strata belonging to the upper carboniferous system but referred the Donets coal-bearing strata to the lower carboniferous system, that is, to carboniferous limestone; and in the absence of fossil remains indicating the order of their stratification he divided them into eight separate groups. This want was soon satisfied by another foreign geologist, Murtcheson, who succeeded in classifying the Donets coal-bearing strata under the same three divisions as he established for the carboniferous limestone of central Russia, in consequence of which he referred the coal veins to the middle division. The Donets basin was subsequently the object of numerous private explorations which brought to light such stores of coal as had never been expected. In the western portion of the basin alone, in the government of Ekaterinoslav, the presence of forty-four workable veins was determined, having a total thickness of 112 feet and a store of 415 milliard pouds of coal at a depth of 100 sagenes. The eastern portion of the basin in the Don province, proved to be still richer in coal. These explorations elucidated the formation and structure of the coal-bearing strata and showed that they might be divided into three divisions as follows:

The lower division, corresponding to culm, containing veins of anthracite coal. The middle productive division, containing caking and coking coal. The upper productive division, containing gas and cannel coal. The rock strata, in which these three divisions occur, consist of sandstone, shale, limestone and intermediate formations.

The coal veins rarely exceed one sagene in thickness. It is remarked that those seams which are not more than three feet thick, generally consist of uniformly clean coal, while the thicker seams often exhibit interlayers of shale or sandstone. In the majority of cases the roof and floor of the coal seams consist of clay shale or sandstone.

The Donets coal field is remarkable not only for its vast extent but also for the great variety of coal it produces. It includes every quality, from soft coal to anthracite. The different varieties of coal are however far from occupying equal areas. Dry coals, burning with a long flame, are only met with in the north-eastern borders, at Zisichansk, and extend over a very limited area; the greasy, gas and smithy coals form a narrow zone between the dry and caking coals. The caking, giving coke suitable for metallurgical purposes, occurs in two separate areas of comparatively large extent; the semi-anthracites form a gradual transition from the caking coals to the anthracites, which cover the whole of the south-western portion of the Donets basin.

The dry coals are hewed in lumps but rapidly disintegrate in the air, and hence they cannot be stored for any length of time, nor be transported to any great distance. They also contain a considerable amount of ash and sulphur. The gas coals are greasy in appearance, are generally hewn into small lumps, but owing to their caking properties and cleaness they are also suitable for house fires. The caking coals are black, dull, small and are used both as fuel and for coke. They contain but little sulphur and ash. The semi-anthracites vary in appearance; some are pitchy, are cut into large lumps with small shining surfaces, but they rapidly disintegrate and burn with a long flame; others are black, with large shining surfaces and burn with a short flame, but owing to the presence of interlayers of clay schist and calc spar they decrepitate, and do not burn well in the fire. Lastly the anthracites are of a brilliant black color with a compact fracture; they are hewn into large, dense lumps, and burn without flame. The following table gives the average chemical composition of the five kinds of Donets coal.

	Volatile substances and water.	Carbon.	Sulphur.	Ash.	Coke.
GROUP I.					
DRY COALS					
with long flame	37·60—50·10	37·70—55·20	0·60—5·15	1·25—8·10	49·10—55·10
GROUP II.					
GREASY COALS					
a. with long flames, gas coals.	27·80—37·40	50·50—67·40	0·50—2·30	1·10 –7·00	58·30—70·40
b. with short flames, smithy coals	26·40—30·60	60·20—72·40	0·25—1·60	1·30– 4·00	69·40 –72·90
GROUP III.					
GREASY COALS					
with short flames, coking coal	12·40 – 23·50	66·60—85·10	0·40—3·10	0·90—8·30	70·30—87·10
GROUP IV.					
Semi-anthracite	10·20—20·30	73·50—87·50	0·20—3·00	1·50—6·20	78·40—89·60
GROUP V.					
Anthracite.	4·20—11·40	85·40 – 91·00	0·60—2·90	2·00—9·00	90·70—95·80

For a long time the Donets coal was exclusively worked by small capitalists and it is only since the construction of railways in the south of Russia, calling forth an increased demand for coal, that the matter was taken up on a large scale and the veins worked in vast and well organized coal mines. At the present time the shafts in some mines are over a hundred sagenes deep. Fire damp has recently made its appearance in some mines in the Donets basin, and there have already been several explosions with loss of life. The accompanying table shows the gradual progress of the development of the Donets coal industry, giving the data for soft coal and anthracite separately.

Years.	Yield of bituminous.	Yield of anthracite.	Total.
	Pounds.		
1855	—	—	4,500,000
1860	2,005,000	4,004,000	6,009,000
1865	4,104,000	5,725,000	9,829.000
1870	2,629,900	13,017,400	15,647,300
1875	25,708,000	25,728,700	51,436,700
1880	57,086,100	29,261,200	86,347,300
1881	58,227,600	33,070,600	91,298,200
1882	73,066,200	33,184,000	106,250,200
1883	75,669,000	31,648,000	107,317,000
1884	70,626,800	30,918,000	101,544,800
1885	82,345,000	32,601,300	114,946,300
1886	95,876,500	32,778,000	128,654,500
1887	97,730,600	27,753,800	125,484,400
1888	105,230 300	31,529,400	136,759,700
1889	145,660,400	44,208,600	189,869,000
1890	146,766,100	36,482,700	183,248,800

MAP OF EUROPEAN RUSSIA

indicating mineral coal regions.

Cartographical works, A. Jlyne, St. Pbg.

Coal regions.

Productiveness of mineral coal, in pouds, in 1890.

Anterior to the Crimean campaign the yield of the Donets basin was in all, according to official data, about one million pouds of bituminous coal in the government of Ekaterinoslav, and slightly over three million pouds of anthracite from the Groushevsk mines in the province of the Don Cossacks. Out of this quantity about two million pouds were consumed in heating private and governmental buildings in the regions of Black and Azov seas, and on the steamers navigating the Black sea and the south Volga and even on the Caspian; the remainder was consumed in the locality. The coal was mainly used for smithies, for the Lougansk foundry works and the Slaviansk salt works. The anthracite was used by steamers and governmental buildings. The above table shows that up to 1875 the amount of anthracite raised constantly exceeded the yield of bituminous coal. The yield of anthracite then almost attained its full extent, due to the measures taken for its production in the province of the Don Cossacks. In 1856 the anthracite industry of the Don province was pronounced free, and the formation of companies for its exploitation was permitted. On March 8, 1864, an Imperial statute was formulated respecting the mining industry in the present province of the Don Cossacks by which all persons, without restriction of being of Cossack origin or not, were admitted to the mining industry of this district. Thanks to this law the production of anthracite began to develop rapidly, and in two years had risen from 3,600,000 pouds, 1864, to ten million pouds, 1866. To this period also belongs the construction of the first special coal railway in Russia, from the Groushevsk anthracite mines to the Cossack village of Aksaisk on the Don, 66 versts in length.

The year 1866 inaugurated the gradual construction of a whole network of railroads in the south of Russia, namely, the Koslov-Voronezh-Rostov (1868—1871); the Kursk-Kharkov-Azov (1869); the Kharkov-Nicolaev (1870—1878); the Konstantinovsk (1872); the Lozovo-Sevastopol (1873); Rostov-Vladikavkaz (1875); Fastovsk (1876); Donets Coal Railway (1878); Mariopol (1882), and Ekaterininsky (1884). The Kursk-Kharkov-Azov Railway, passing through the western portion of the Donets basin, including the richest coal deposits, was opened in 1869 along its entire length of 763 versts. This railway gave the possibility of finding a market for the Donets coal which up to that time had been exclusively transported by oxen, and could not therefore have an extensive sale. How great an influence this railroad had in developing the production of the Don coal field is seen from the fact that it rose from 2,250,000 pouds, extracted in 1862, to 47,000,000 pouds in 1879. Thus, it increased twenty-one times in the space of eleven years. The Koslov-Voronezh-Rostov Railway connected the anthracite mines of the eastern portion of the Donets basin with the general network of Russian railroads, thus giving the possibility of selling the anthracite in the interior of Russia. The Kharkov-Nicolaev and Lozovo-Sevastopol railroads opened out the Black sea ports to the Donets coal; and the Fastovsk railroad connected the Don basin with the rich region of the sugar industry. The Donets Railway, whose branch lines intersect the Donets basin in various directions, connected the Kursk-Kharkov-Azov with the Koslov-Voronezh-Rostov Railway and gave a free outlet to the coal from the mines lying between these two lines, and animated the coal industry of the district to a very great extent. The connection of the Donets basin with the rich iron ore deposits of the Krivoy-Rog by means of the Ekaterininsk Railway, which extended to the Kharkov-Nicolaev line, called forth the erection of extensive iron and steel works in the neighbourhood of this railway. And lastly the extension of the Konstantinovsk line to Mariopol on the Azov sea and the construction of a port for coasting vessels

with machinery for automatically loading the coal into them at Mariopol, opened out the most direct and easy routes between the coal mines and the sea, and gave the means of quick and cheap transportation to the ports of the Black sea, of which Odessa, formerly supplied by England exclusively, offered the greatest demand. The construction of the above mentioned railroads, the gradual growth of the industries of the south of Russia, the increasing traffic on the railways, necessitating an increased demand for fuel, the regulation of the transport of coal and of the railway tariffs, a protective duty upon the coal and coke imported to the ports of Black sea and Sea of Azov, all of these factors had an influence upon the rapid development of the coal industry of the Donets basin, which has doubled in its production during the last ten years. It must be remembered that the coal trade of the south of Russia is almost exclusively supported by markets situated at a distance, and that the local consumption is very inconsiderable. In general the coal industry would develop incomparatively quicker were it not that the coal has to be transported great distances by railways, which are not always to be depended upon for quick dispatch of their freight. As regards the distribution of the Donets coal between different classes of consumers, there are very accurate official data respecting the consumption of coal transported from the western portion of the Donets basin for the last ten years, but these data do not include anthracite.

Class of Consumers.	1880.	1885.	1890.
	Trucks *.		
Railroads	36,781	55,973	60,911
Black sea fleet	6	648	117
River and sea navigation	3,780	6,036	13,124
Gas works	535	775	2,994
Metallurgical works	326	190	34,745
Sugar works	11,420	15,362	19,274
Manufacturing industries and house heating	11,711	39,846	64,542
Total	64,549	118,830	195,707

Thus we see that during the last ten years the total consumption of coal has increased by three times. The separate items of the above table cannot be subject to comparison because the amount of coal consumed by the railroads and sugar works in 1890 was not normal, owing to their having laid in considerable stocks of coal for that year fearing a repetition of the coal crisis of 1888 to 1889. In 1889 the railroads were supplied with 84,426 trucks of coal and the sugar works with 30,640, that is, the former with 40 per cent, and the latter with 52 per cent above the demand in 1890. On the other hand, the newly erected metallurgical works in the south of Russia consumed a considerable amount of coal and coke. During the last two years the yield of coke in the Donets district was in 1889, 10, 207,376 pouds and in 1890, 17,081,211 pouds.

* One truck contains 609 pouds.

In 1890 there were altogether 270 coal mines in work in the Donets basin; of this number 195 yielded anthracite and 75, bituminous coal. As the preceding table shows that in 1890 the yield of soft coal was four times greater than that of anthracite, it is evident that the latter was chiefly worked by small capitalists, although there are mines yielding more than four million pouds of anthracite; but on the other hand there are a number of mines with an output of less than 30,000 pouds. Among the coal mines proper there are some which give five, eight, fifteen and even twenty-two million pouds annually.

The Moscow Basin.

This coal region extends over the governments of Tver, Moscow, Kalouga, Tula, and part of the governments of Novgorod, Smolensk, Riazan, Vladimir and Tambov. This central field of carboniferous strata is six hundred versts long and over four hundred wide. To the north the carboniferous strata spreads out in a rather wide band across the governments of Olonets and Archangel to the White Sea. The coal bearing strata of the Pod-Moscow basin are chiefly limestone; the coal veins lie between limestone of the lower division and strata of the Devonian period. In some places limestone of the carboniferous system lies between the Devonian and the coal bearing strata.

The presence of coal in the Pod-Moscow basin was known at the close of the last century; the first veins were discovered in 1768, on the borders of the basin in the government of Novgorod, and in 1796 in the government of Riazan. The rapid extirpation of the forests in central Russia caused the Government to turn its attention to the coal veins of the Moscow basin, and to make repeated endeavours to establish the exploitation of coal there. In 1851 a third and detailed exploration was made of the coal veins in the government of Tula. This exploration was conducted by two parties, one geological and the other mining, which after two years of work came to the conclusion that the coal of the government of Tula was of unsatisfactory quality and occurred in the form of interrupted masses unsuitable for regular working. This opinion was retained until the close of the fifties when Count Bobrinsky, being in want of fuel for his sugar works, began to make explorations of this question on his Malevka estate in the government of Tula, where he discovered a vein of coal which proved to have a vast horizontal extension. The exploitation of this vein was begun and induced other landowners to make surveys which also led to satisfactory results and the opening out of fresh coal mines.

The rapid growth of the railway system in Central Russia, about 1865, called forth a more active exploitation of the coal in the government of Riazan and Tula. In general the growth of the coal industry in the Moscow basin is represented by the following data.

Years.	Yield of coal. Pouds.	Years.	Yield of coal. Pouds.
1860	631,250	1884	24,009,500
1865	1,371,300	1885	21,307,500
1870	5,078,500	1886	15,652,300
1875	23,658,600	1887	17,589,100
1880	25,117,800	1888	16,865 000
1881	23,426,200	1889	18,697,300
1882	24,400,300	1890	14,268,100
1883	22.731,500		

The decrease in the production of coal from the Moscow basin during recent years is due to the competition of the Donets coal, which is of far better quality, and also to the increased adoption of naphtha refuse in the place of Moscow coal and peat in the Moscow manufacturing district.

At the present time the presence of coal has been certified in over two hundred places in the Moscow basin, but only twelve mines are worked. This is due to the fact that only a few veins are of a workable character, and also to the fact that the coal is often of very poor quality and does not permit of being transported to any distance, or of being exposed to the atmosphere for any length of time; it often contains also a considerable amount of ash. This coal does not coke. Thus the Moscow coal is combustible, and of rather poor quality, which however is suitable for heating steam boilers and buildings and for making gas. The chief consumers of this coal are the railways of central Russia and certain local works. The chemical composition of the Moscow coal is as follows:

Carbon	from	24·5	to	50·8	per	cent
Volatile matter .	»	24·1	»	49·1	»	»
Moisture	»	3·1	»	15·9	»	»
Ash	»	9·0	»	22·4	»	»
Sulphur.	»	2·0	»	14·4	»	»

The best kind of Moscow coal is the so-called b o g h e a d, which is distinguished for the large amount of hydrogen it contains, and the considerable quantity of gases it gives by dry distillation.

The Kiev-Elisavetgrad Basin.

Although veins of brown coal have long been known to exist in the neighbourhood of Kiev, the quality of the coal was too bad to be of much use. In 1860, thicker veins of brown coal were discovered on the Ekaterinopol Crown estate in the Zvenigorodsk district and on Count Bobrinsky's estate of Smela in the Cherkassk district of the government of Kiev. These veins are now being worked. Subsequently several other veins of brown coal were discovered along the Fastovsk Railway but none of these have been worked. Geological surveys have proved that the coal of the Kiev-Elisavetgrad basin belongs to the tertiary system and that the strata containing the brown coal extend to the government of Kherson, and also that the area over which new coal veins may be looked for, in the governments of Kiev and Kherson, extends over about five thousand square versts. The following table gives the production of the Kiev-Elisavetgrad basin since 1868.

Years.	Production of coal.	Years.	Production of coal.
	Pouds.		Pouds.
1868	103,000	1885	554,700
1875	1,093,000	1886	859,700
1880	534,400	1887	558,900
1881	584,200	1888	215,000
1882	656,600	1889	853,000
1883	571,600	1890	693,300
1884	635,000		

The Polish Basin.

This coal region is situated at the very south-western corner of Poland and embraces a portion of the Bendinsk district of the government of Petrokov and of the Olekoushsk district of the government of Kelets. From a physiographical point of view it forms a continuation of the so-called Polish-Silesian basin, whose western part lies within the limits of Prussia and southern part within those of Austria. The superficial aspect of the Polish basin is in intimate connection with its geological structure. In general the district is undulating, descending in a south-western direction, and in so doing presents a transition from the newer to the older strata. The strata of the carboniferous system come to the surface surrounded by trias, keiper, jurassic strata, and on the average rise to 900 feet above the level of the sea. The area of the entire Polish-Silesian basin, in which there is reason for supposing it to be a continuation of the upper coal-bearing formations of the carboniferous system, extends over about 5,800 square versts, of which four thousand are in Prussia, one thousand in Austria and about eight hundred in Poland. The portion upon which the presence of coal veins has been revealed by mining explorations covers an area of about 2,100 square versts of which about nine hundred are in Prussia, seven hundred in Austria and about five hundred in Poland.

In their petrographical relation the carboniferous strata of the actual Polish basin consists of sandstone and schist which frequently pass imperceptibly from one into the other. The carboniferous system of this district includes coal, iron ore, sandstone and fire clay, all of which are worked.

Paleontological data show that the entire Polish-Silesian basin may be divided as follows:

1. The upper productive division which includes the coal veins.
2. The lower division or "Culm" which does not contain coal and covers the first.

The upper division may in its turn be subdivided into, the upper and the lower. The upper subdivision is characterized by the considerable thickness of the coal veins; the lower, although it includes a considerable number of coal veins, does not present any of great thickness. The coal veins, which are known in Poland, chiefly belong to the upper subdivision.

From an industrial point of view the most important zone of carboniferous formation in the entire Polish-Silesian basin is that which extends into Prussia from Zabrzhe to Mislovitsy and farther to the east into Poland and to Austria on the south-east. The chief production of coal is centred within the limits of this zone.

The coal veins worked within this zone are divided into three groups: 1. The middle group including a thick vein, known as the Reden vein in Poland and the Sattel-Flötz in Germany; 2. The upper group of veins lying above the Reden; these veins are not so thick as the Reden, and the coal is of a different quality; 3. The third group of veins lies below the Reden and is also of less thickness. In Poland all the three groups are worked. The thickness of the veins and the quality of their coal is far from being constant throughout the entire range of the above mentioned zone. For instance, in Poland the Reden veins have an average thickness, from four to seven sagenes, but as it extends to the west this vein is divided by interlayers of dirt, first into two, then three, and lastly into four separate veins, each from one to four sagenes thick. The quality of the coal

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also varies as the seam subdivides and thins out. At the western extremity near Zabrzhe in Prussia the Reden group of veins contains coking coal. At the same locality the lower veins of the upper group, lying above the Reden vein, contain gas coal, and it is only the coal of the uppermost veins that should be referred to the class of poor coals. Nearer to the Polish frontier the Reden veins are no longer coking but are still serviceable for the preparation of gas. Lastly in Poland the Reden and the overlying veins give neither coking nor gas coal. In Poland the number of upper veins overlying the Reden amounts to twelve, having a total thickness of nine sagenes. Here the average thickness of the Reden vein is from seven to ten sagenes. And lastly there are nine veins having a total thickness of about seven sagenes, underlying the Reden vein. All these veins have a common extension from the north-west to the south-east, and dip in a south-western direction. Outcrops of the Reden vein are known at a great distance. To the south in Poland, the Reden and the other coal veins crop out and form a basin filled with trias formations. Owing to the convolution of the entire series of the formations of the carboniferous system, the Reden vein is worked in different places at very different depths, from 35 to 120 sagenes, and at one point a new shaft has been sunk to a depth of 140 sagenes. The veins overlying the Reden are worked at a depth of 18 to 30 sagenes.

The work of exploitating the coal in Poland was up to recent times conducted on the same plan as in the neighbouring Russian Siberia, that is, by letting the roof fall in. But with this mode of working the far greater thickness of the Reden vein in Poland caused numerous accidents, while the impossibility of winning all the coal led to considerable waste. Moreover the disintegration of portions of the vein and the consequent self-combustion of the coal occasioned frequent fires in the mines, which sometimes continued for several years and necessitated such radical measures, as flooding whole groups of large coal mines. In consequence of this the Government recently turned particular attention to this matter and now the exploitation must be carried out according to Government regulations. By these regulations, those veins which are over two to three sagenes thick according to the local conditions, can only be worked by filling up the worked out spaces with goaf. Besides the frequent occurrence of fires, the Polish mines present another difficulty owing to the inconsiderable thickness of the superincumbant carboniferous formations in some localities, owing to which the mines are insufficiently protected from the bursting in of water, from the overlying strata of varigated sandstone, which is exceedingly watery. Due to the hardness of the coal in the veins, worked in Poland, it is everywhere blasted by gunpowder. This is possible, thanks to absence of oxyhydrogen gas.

As regards the deposite of brown coal occurring in the Bendinsk district of the government of Petrokov, they belong to the Keiper system and occur in veins about one sagene thick.

The chemical composition of the coal of the different groups is as follows.

	Volatile matter and water.	Carbon.	Ash.	Coke.
Reden vein.	35·5—41·6	53·1—63·6	2·3—7·7	58·3—66·0
	24·5—25·6	70·5—71·3	3·7—4·0	—
Lower group of veins.	27·1—29·5	64·5	5·8—7·1	—

The exploitation of coal in Poland dates from the close of the eighteenth century, but only attained considerable dimensions after 1816, when the Polish zinc works were started. The production of the coal mines increased with the development of the zinc works, and with various fluctuations it reached a yield of ten million pouds a year, after 1860. The Polish insurrection in 1863 and the liberation of the mining population from obligatory labour in 1864 evinced an unfavourable influence on the Polish coal industry, but on the other hand there were many other factors which acted very beneficially on its development. The chief of these were the following: 1. The opening of a branch line of the Warsaw-Vienna Railway to the Prussian frontier; this line intersected the Polish coal basin and gave possibility of transporting the coals to Warsaw and other industrial centres; 2. The development of the metallurgical and manufacturing industries in the region of the Warsaw-Vienna Railway, with the almost exclusive employment of mineral fuel; 3. The growth of the application of coal to house-heating; 4. The publication of a new mining law for Poland in 1870; this law called forth the participation of exceedingly active private enterprise in the construction of new coal mines and in consequence a rapid rise in the production of coal since 1872; 5. The transference of the most important State coal mines into private hands; 6. The construction of the Ivangorod-Dombrovsk Railway during the beginning of 1880; this railway gave the possibility of supplying Polish coal not only to fresh markets within the limits of Poland itself, but also to the west and south-west of Russia, by a shorter route and without the reloading, which was formerly necessary owing to the difference between the guage of the Warsaw-Vienna Railway and that of all the other Russian roads.

The gradual growth of the Polish coal industry is seen in the following table.

Years.	Production of coal.	Production of brown coal.	Total.
	Pouds.		
1855	—	—	4,454,000
1860	—	—	10,787,900
1865	10,592,900	150,000	10,742,900
1870	19,580,600	498,800	20,079,400
1875	23,985,600	918,100	24 903,700
1880	77,395,900	1,053,000	78,448,900
1881	85,303,800	470,900	85,774,700
1882	83,665,000	665,700	84,330,700
1883	101,786,600	606,600	102,393,200
1884	102,816,700	656,600	103,473,300
1885	108,075,000	1,207,500	109,282,500
1886	118,605,900	1,451,600	120,057,500
1887	119,747,200	1,409,000	121.156,200
1888	145,918,400	1,438,700	147,357,100
1889	149,314,600	1,794,400	151,109,000
1890	149,586,700	1,205,800	150,792,500

At the present time there are twenty coal mines in Poland, one of which raises brown coal. The yearly output of the chief coal mines ranges from eleven to sixteen

million pouds, but one, the George pit, gave 34,436,000 pouds in 1890, from two shafts. These mines are furnished with powerful steam engines both for haulage and for pumping the water out of the mine. The majority of the mines have plants for sorting and some for washing the coal. They are nearly all connected by branch lines with the Warsaw - Vienna Railway and some of them also with the Ivangorod - Dombrovsk line. The Warsaw-Vienna Railway transports the largest amount of Poland coal; thus, in 1890 this line carried 93,814,600 pouds. The largest consumers within the region of this railway are the town of Lodz, with its manufacturing neighbourhoods, which consumed 30,613,000 pouds in 1890, and Warsaw, 26,000,000 pouds; then part of the coal, carried by the Warsaw-Vienna Railway, the most important route for the Polish coal field, is the Ivangorod - Dombrovsk Railway, which carried 18,980,600 pouds of coal in 1890; out of this quantity 5,376,900 pouds were transferred to the South - Western, Fastov, Koursk - Kiev, and Kharkov-Nikolaev railways. Taking the average results for recent years, the demand for Poland coal, including its consumption by railways, was distributed in the following manner:

	Pouds:
The region of the Warsaw-Vienna Railway	85,000,000
» » » » Ivangorod-Dombrovsk Railway	9,500,000
» » » » Vistula Railway	7,700,000
» » » » Warsaw-Terespolsk Railway	2,200,000
Consumption by the Lodz manufacturing district lines	500,000
Transferred to the South - Western, Fastov, Koursk - Kiev and Kharkov-Nikolaev railways	5,200,000
Transferred to the Moscow-Brest railways	1,200,000
» » » St.-Petersburg-Warsaw railways	2,000,000
	113,300,000

Moreover, about 40,000,000 pouds of coal are consumed in the neighbourhood of the pits, that is, in the district of Sosnovitsi, where a considerable amount is consumed by the metallurgical works.

The Urals.

Carboniferous formations occur on both sides of the Urals. On the western side they form an almost uninterrupted band extending along the greater part of the strata. Besides this they also appear in separate patches generally among more recent formations. On the eastern side the carboniferous formations generally occur in small, narrow and interrupted bands and patches, sometimes jammed between massive, crystalline rocks. In their mode of stratification the coal measures of the western Urals present an almost entire similarity to those of the Moscow field, which similarity extends to the position of the coal veins, forming the basis of the system between the lower carboniferous limestone and the Devonian formations. As in the Moscow basin, carboniferous limestone in some places occurs above the latter, but beneath the coal measures. In its quality the coal of the western side of the Urals differs from that of the Moscow basin, being a true coal without any resemblance to the brown coals or boghead to which the Moscow coals more or less approximate. The exploitation of coal on the western side of the Urals is concentrated in a small area to the north, where the thickness of

the coal veins varies between a half and two and a half sagenes. The coal is poor and in some rare cases after being washed gives a caking coke.

The carboniferous formations of the eastern side of the Urals are distinguished for their comparative complexity and the originality of the upper division of the system. The lower division offers an almost perfect resemblance to the corresponding division of the western side and of the Moscow basin, being composed of lower carboniferous limestone and an underlying strata of coal measures stratified directly on Devonian formations. The most important coal-bearing area on the eastern side of the Urals extends for a distance of about a hundred versts in a southern direction. In this band may be distinguished the northern portion containing poor soft coal and anthracite, and the southern portion containing coking coal. Besides this there are areas where graphite is found with anthracite and where beds of graphite occur alone.

Although the exploitation of coal in the Urals was first, from 1851 to 1860, exclusively conducted on the eastern side, where the presence of coal of good quality has recently been certified, nevertheless at the present time the working of coal is almost entirely centred in the northern portion of the western side of the Urals. The following table shows the progress of the exploitation of coal here since 1855.

Years.	Yield of coal. Pouds.	Years.	Yield of coal. Pouds.
1855	440,000	1883	7,671,000
1860	408,000	1884	7,723,000
1865	766,200	1885	10,875,400
1870	387,400	1886	12,107,000
1875	1,278,900	1887	9,972,100
1880	7,217,400	1888	12,757,100
1881	10,031,300	1889	16,040,000
1882	12,253,400	1890	15,223,600

Up to 1870 the yield of coal was subject to repeated fluctuations owing to various external conditions. For instance, in 1864 more than a million pouds of coal were raised owing to the temporary transfer of the Vsevolozhsk coal mine to a private company, which supplied coal during that year to the steamers navigating the Volga, Kama and Oka. It was only in 1871 that the exploitation of coal became more active and regular in this district, and it received a great impetus in 1879 when a branch line of the Ural Railway was constructed intersecting the coal district of the western side of the Urals and extending to the banks of the river Kama.

Nearly all the coal raised in 1890 was obtained from four coal mines on the western side of the Urals. The Ural coal goes to the railways, local metallurgical and salt works, and a small quantity is transported down the Kama. The production of coke in the Urals during the last two years was in 1889, 589,700 pouds; and in 1890, 572,800 pouds. These figures show the small application of the Ural coal to metallurgical operations.

In 1875 coal was also discovered and explored in the government of Olonets on the north-western shores of lake Onega. In its composition this coal resembles anthracite, but owing to its mode of occurrence it does not deserve serious attention.

The coal fields of Asiatic Russia.

The presence of coal is known both on the northern and southern declivities of the Caucasus. Professor Abikh has shown that the coal veins on the northern side of the Caucasus lie on two levels and occur throughout the area of extension of the sandstones of the middle division of the jurassic system. Coal has here been worked since 1846 on the banks of the river Kuban, where it occurs in thin veins. The Kuban coal is black, rather bright and hard; it frequently contains pyrites and interlayers of gypsum, and also large nodules of spherosiderite. It burns with a bright flame and gives a caking coke. Besides the coal of the northern side of the Caucasus, deposits of a combustible shale, also belonging to the jurassic system, are worked in the province of Daghestan.

On the southern side of the Caucasus, coal is exploited in the government of Koutais at Tkvibula, 45 versts to the north of the town of Koutais. These coal veins are famous for their great thickness. The coal here occurs in several veins, lying one above the other and having a total thickness of seven sagenes. The property of the coal varies greatly in the different veins both in its external appearance and in chemical composition. The coal fields in the neighbourhood of Koutais also belong to the lower jurassic period. In 1890 two mines were worked on the Tkvibula coal deposit, and 457,500 pouds of coal were raised.

The Western Siberian Fields.

The most important coal field in this region is that of Kusnetsk situated in the south-eastern corner of the government of Tomsk, between the mountain chains, Salairsk and Altai. This coal field presents a vast basin divided into two parts along its length by the river Tom. It is 420 versts wide and 105 versts long, or about forty-four thousand square versts in area. This coal basin, which is one of the most vast in the world, contains many thick veins of excellent coal. The geological formations of the district belong to the post-tertiary, devonian and carboniferous periods. The coal measures belong to the last mentioned age.

Explorations conducted at different periods have shown that in many parts of the Kusnetsk basin there exist vast series of coal veins, varying in thickness from three feet to over six sagenes. It has been estimated that the store of coal in this field amounts to millards of pouds. The presence of coal in the neighbourhood of the town of Kusnetsk was already known at the beginning of the last century. At the present time only two mines are worked, which in 1890 gave an output of 1,051,540 pouds of coal. The oldest of these mines the Bachatsk, works a vein which varies in thickness, and in some places attains 25 sagenes; the quality of the coal also varies in different parts of the vein. In the middle portion the coal is dry, dense, dull, does not coke and burns almost without flame. In the upper and lower portions the coal is semi-greasy and greasy, friable, bright, burns with a flame and gives a good caking coke. In the Kolchoughin mine four veins are known, varying between six feet and two sagenes in

thickness, and lying almost horizontally. This coal gives a caking coke and does not contain more than 2 per cent of ash. The coal extracted in the Kusnetsk basin is chiefly used in the metallurgical industries of the Altai district. During the last two years the production of coke in the Kusnetsk basin was in 1889, 310,700 pouds, and in 1890, 412,700 pouds.

Coal veins are known in various parts of the Kirghiz steppes where they were first discovered in 1838. Different coal veins have been worked here at various times but all the workings were surface mines, and detailed explorations were nowhere made, nor the store of coal determined. According to the testimony of persons who have made geological surveys in the Kirghiz steppes the coal measures occur exclusively in strata of the carboniferous system. The coal of this district varies extremely in quality, some kinds giving a caking coke of good quality. In 1890 there were eight mines in work, yielding 62,500 pouds of common coal, 64,200 pouds of brown coal and 30,000 pouds of combustible shale.

In Eastern Siberia, coal veins have been discovered in different localities, in the governments of Yenisseisk and Irkutsk, in the Zaibaikal, Amour and seacoast provinces, and also in Kamchatka. Those of the seacoast provinces are most important and are the only ones which have been exploited. The Island of Sakhalin, which forms, as it were, a perfectly separate formation from the continent, is distinguished for the richness of its carboniferous formations. Thanks to surveys first made in 1851 a whole series of coal deposits was discovered extending from the northern extremity of the island along the western coast to its southern extremity for a distance of 950 versts, and also on the eastern shores and interior of the island. The extent of the coal veins, containing very good quality coal, is especially remarkable in the central portion of the western coast.

Notwithstanding the fact that the coal here lies in strata of the tertiary system, it is, as for instance at Doué where the coal is exclusively worked, of excellent quality and does not cede to the best sorts of Welsh coal. It contains from 74 to 84 per cent of carbon, a very small amount of ash and sulphur, and gives 60 per cent of clean metallic coke. The coal veins of the island of Sakhalin rarely exceed three feet in thickness, but they are easily worked by levels driven to the coal itself, which crops out along the steep seashore. The coal is supplied to the Russian fleet in the Pacific ocean and also to foreign commercial and war vessels, and the yield corresponds to the above demand.

As however the coal mines of the island of Sakhalin are at a great distance from Vladivostok, the chief port for the Russian Pacific fleet, and as coal veins have been discovered along the entire southern portion of the seacoast province from the bay of St. Olga to the very frontier of Corea, not only along the entire coast, but also in the interior, the Russian Government started a detailed exploration of the whole of the so-called South-Ousourisk region in 1886. In some places the coal veins have been worked since the beginning of the sixties. The most favourable and the richest of all these coal veins is situated on the river Souchan at a distance of 45 versts from the junction of this river and the Gulf of America. The coal veins here vary between three and seven feet in thickness and consist partly of caking and coking coal, and partly of a smokeless coal, resembling the Cardiff coal.

The absence of fuel in the Turkestan provinces induced the Government to take

measures for the exploration and survey of the coal deposits, said to exist in various parts of the country. These explorations resulted in the discovery of coal veins in different localities, some of which are now under exploitation. In the Syr-Daria province the presence of coal in the Karatau mountains became known after the first appearance of the Russian troops in that country, although the natives knew of the existence of this fuel. Preliminary explorations of these coal veins, prospecting for fresh measures, and their ultimate exploitation were undertaken in view of the possibility of furnishing the flottilia of the Sea of Aral with coal. Coal is worked in the neighbourhood of Chemkend, Tashkend and Hodgend, where some of the veins are as much as 2·5 sagenes thick. Sometimes series of coal veins, overlying each other, are met with. In 1890 there were six mines in operation in Turkestan, which gave a total output of 300,900 pouds of brown coal.

In conclusion the two accompanying tables give the chemical composition of the coal from the various regions of Asiatic Russia, and the production of those regions in pouds.

	Volatile matter.	Carbon.	Ash.
	Per cents.		
Caucasus, Kouban . . .	37 —43	51·4—58·9	3·1— 5·6
» Tkviboulsk . .	37·9—43·0	39·1—55·5	2 —23·0
Kouznetsk basin	17·7—25·8	67·8—74·7	2 — 8·0
Sakhalin	26·3—30·3	53·4—68·0	2 —10·0
Kirghiz steppes.	10 —42·0	27·5—64·4	4 —25·0
Turkestan	34 —40·0	55·3—56·8	2 —10·0

Years.	Kousnetsk basin.	Kirghiz steppes.	Seacoast provinces, Island of Sakhalin.	Turkestan.	Caucasus.
1860	55,000	185,100	133,000	—	100,000
1865	267,200	202,200	8,400	—	145,000
1870	350,000	477,900	123,200	75,000	197,900
1875	256,450	832,500	95,900	415,000	377,100
1880	484,650	1,240,000	501,900	305,200	387,300
1881	487,100	1,051,100	317,500	—	218,200
1882	422,300	1,064,900	707,200	—	108,000
1883	370,400	1,269,700	371,250	—	102,600
1884	542,200	1,516,800	424,000	—	52,600
1885	795,400	1,635,600	549,900	417 500	213,000
1886	873,000	306,600	409,800	340,500	133,000
1887	807,800	72,500	556 300	365,700	215,700
1888	1,010,400	91,700	600 300	426,100	511,400
1889	895,500	174,700	650,200	423,200	667,000
1890	1,051,500	126,700	892,500	300,900	604,700

Salt.

In Russia there are all the three sorts of salt, namely, 1. rock salt, 2. salt lakes, 3. salt springs; all of which are distinguished for their richness. (See map of the regions of salt production).

I. Rock salt is known in the following localities:

1. The Ilets deposit of rock salt is situated about 70 versts to the south of Orenburg and is one of the largest in the world. Surveys made here have shown that the salt occurs in an immense bed, the limits of which have not been accurately determined either in a vertical or horizontal direction. It is only known that the salt lies in a continous mass over an area of more than three square versts, for a depth of over 65 sagenes, and that the store of salt contained in this area is determined to be over fifteen milliard pouds. The Ilets salt is also unrivalled for its purity. The whole bed is pure throughout, with only three thin interlayers of red clay and gypsum. This deposit belongs to the State and is rented out to private individuals.

2. The salt deposits of the mountain of Chapchachi is situated in the government of Astrakhan, at a distance of about 90 versts to the east of the Volga. This deposit consists of a continuous bed, extending for a distance of about three versts with an average breadth of about one verst. Its thickness has not yet been accurately determined but it is not less than 42 sagenes, to which depth borings have already been made.

3. The Bakhmout or Briansk salt beds in the government of Ekaterinoslav, were only discovered about fifteen years ago. The idea of seeking salt in this locality arose from the presence of two salt springs, near the towns of Bakhmout and Slaviansk, situated at a distance of about forty versts from each other. But the actual likelihood of the occurrence of rock salt in the southern portion of the government of Kharkov and the northern portion of that of Ekaterinoslav, was first promulgated in 1841 by Le Play, after his exploration of the Donets coal basin. And in 1870 detailed geological surveys of the country between Bakhmout and Slaviansk fully confirmed this supposition. On the basis of these data, two bore-holes were sunk by private individuals near these towns, with the result that rock salt was actually discovered.

In 1876 the Government sank two holes, one near the village of Briantsevka about 10 versts from Bakhmout. This hole encountered the first bed of salt, 4·5 feet thick, at a depth of forty sagenes, and then another bed, 17 feet thick, at a depth of 46 sagenes. The boring was continued, to a depth of 109 sagenes, and passed through seven more layers of salt, in the last of which it was stopped before having passed through its entire thickness; altogether 49 sagenes of pure salt were bored. If this thickness of the beds be compared with the area covered by the Slaviansk-Bakhmout basin, it will be readily understood what an importance this discovery had for not only the south but the whole of Russia.

4. In the Caucasus, rock salt is worked in the government of Erivan, namely at the Koulpin, Nakhichevan and Soustin deposits, and also in the province of Kars at the Kaghyzman and Olitinsk deposits.

5. In the Transcaspian province a bed of rock salt is known in the neighbourhood of the gulf of Krasnovodsk. This bed was originally the now dried up lake of Karababa. The exploitation of this deposit is carried on irregularly.

II. In Russia there are brine evaporating works in the following localities:

1. In the government of Perm there are saltworks at a distance of about 400 versts above the town of Perm up the river Kama. These are the Ousolsk, Lenvensk, Dedukhinsk, Beresinsk and Solikamsk works.

2. In the government of Archangel salt is extracted both from brine and from the water of the White sea.

3. In the government of Vologda salt is extracted at three works, the Ledensk, Totemsk and Seregovsk works.

4. In the government of Nizhni-Novgorod brines are known near the town of Balakhna where there are now eight salt works in action.

5. In the government of Kharkov there are over twenty salt works, in the town of Slaviansk.

6. In the government of Ekaterinoslav there are works in the town of Bakhmout.

7. In the government of Warsaw, the Tsekhotsinsk Salt Works are situated close to the Prussian frontier.

8. In eastern Siberia there are ten salt works, four of which are situated in the government of Yenissei, three in the government of Irkutsk, two in the province of Baikal and one in the province of Yakutsk.

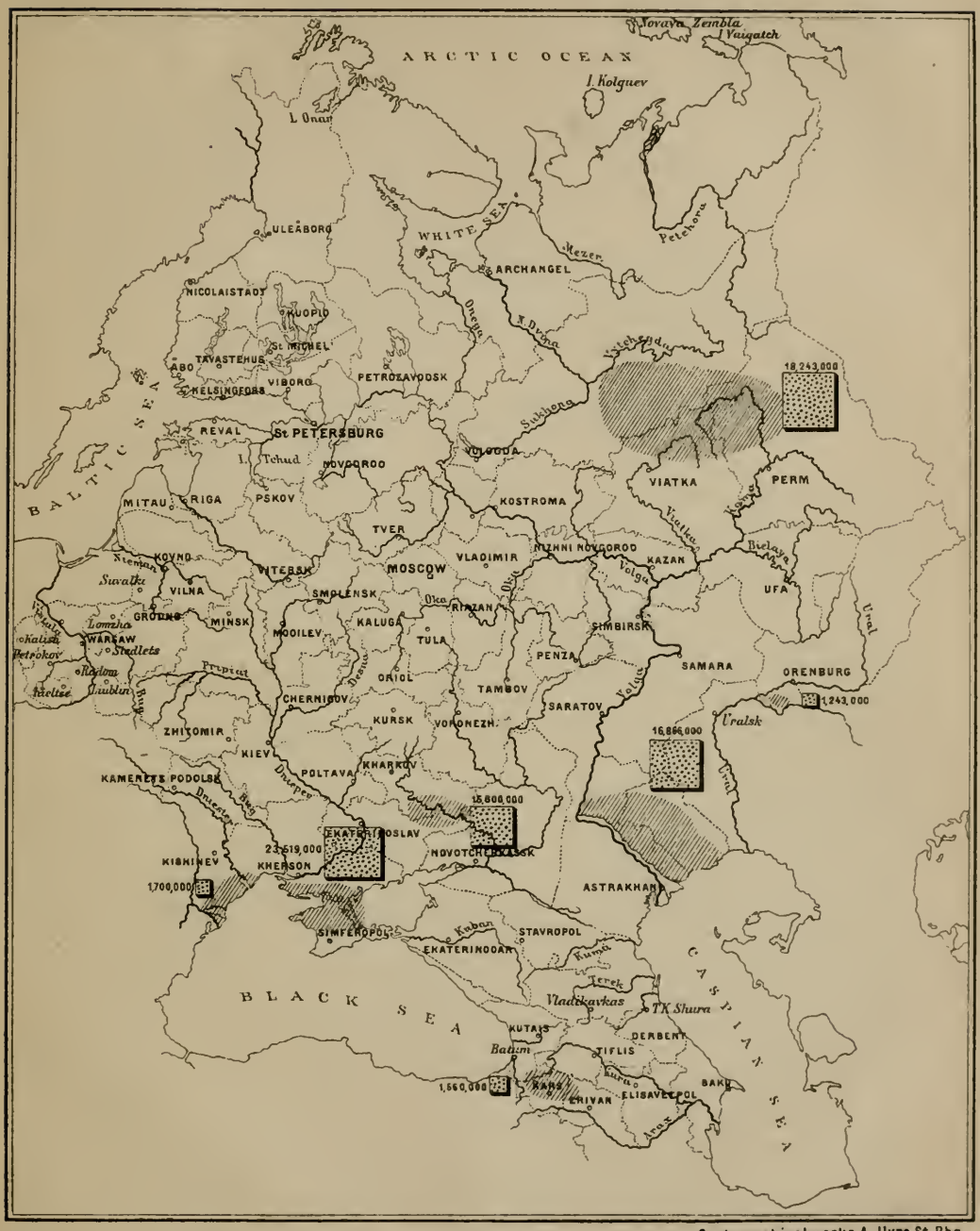
III. In Russia, salt lakes are very widely distributed and occur in numberless quantities.

1. The government of Astrakhan, which forms the comparatively lower portion of the great Aral-Caspian plane, abounds in salt lakes and marshes. The chief of the salt lakes is the Elton situated on the left side of the Volga at a distance of about three hundred versts from the town of Saratov. This lake is perhaps the richest of all the deposits of salt yet known. It covers an area of over two hundred square versts. The bottom of the lake is covered throughout with a vast layer of salt, whose thickness however has not yet been determined. The inexhaustibility of the stores of salt in this lake is already proved by the fact that during the space of 150 years it has yielded over 550 million pouds of salt without leaving any traces to show that any such amount has been extracted. In the Baskounchak lake, situated at the foot of Mount Bogdo, fifty versts to the east of the Volga, the bottom is also covered with a rich layer of salt. The area of the lake is about 110 versts. Investigations made at a depth of 25 sagenes at the bottom of the lake, showed the existence of three layers of salt, the upper of which, now worked, is from three to four sagenes thick, the second is one sagene, and the third was explored for five sagenes without passing entirely through it. The upper layer alone is estimated to contain forty-five milliard pouds of salt. A special railway line has been constructed for carrying the salt from the Baskounchak lake to the Volga, thanks to which the yield has been greatly developed. The salt extracted from this lake is very pure. Besides the Elton and Baskounchask lakes, the government of Astrakhan includes as many as seven hundred salt lakes, and up to one thousand two hundred salt marshes.

2. The salt lakes occurring in the Tauride government, are known under the common term of the Crimean lakes, and according to their geographical position, may be divided into the internal, lying in the Crimean peninsula itself, and the external, which occur in the northern portion of the government, in the Dnieper and Melitopol districts. All the Crimean lakes lie in proximity to the seashore, from which

MAP OF EUROPEAN RUSSIA

indicating salt regions.



Cartographical works, A. Jlyne, St. Pbg.

Regions of productiveness.

Productiveness of salt, in pouds, in 1890.

they are separated by narrow stretches of sand. The brine of these lakes only reaches saturation in the summer, in specially constructed basins where the salt is deposited in layers several inches thick. The extent of the deposit of salt in these basins is entirely dependent upon meteorological conditions; thus during a hot summer the yield of salt is far greater than during a rainy season, when the process of deposition is much slower. Hence it will be understood that the success of the Crimean salt industry is greatly dependent upon chance, and that the lakes differ essentially in many respects from those in the government of Astrakhan.

3. In the government of Kherson the Kouyalnitsko-Hadgibeisk salt workings are situated near Odessa on the Kouyalnitsk liman.

4. In the province of the Don Cossacks is the Manych salt lake.

5. In the government of Stavropol is the Chalginsk self-depositing lake and on the borders of the government of Astrakhan, the Mozharsk and Gaidouksk lakes.

6. In the Caucasus there are salt lakes in the governments of Baku, Daghestan and Kouban.

7. In Asiatic Russia salt lakes are under exploitation in the provinces of Tourgaisk, Semipalatinsk, Yakutsk and Baikal, in the government of Tomsk, and also in the Transcaspian and Fergan provinces.

From the above it will be seen that Russia is in general very rich in salt, and would be able not only to amply supply itself but also to furnish other countries. But the geographical distribution of its stores is such that the chief natural sources mainly lie in the southern, eastern and north-eastern limits of European Russia, which until recently had no regular means of communication. This is the chief reason of the comparative high price of salt at the points of its consumption, although it is extremely cheap in the neighbourhood of its extraction. Under such conditions the growth of the demand for salt has up to very recently made little or no progress and some governments, namely the western and north-western, were obliged chiefly to consume foreign salt.

The furnishing of the Empire with salt was always a subject of special care to the Government. Up to 1862 a particular so-called monopoly system was in vogue. The Government, as the proprietor of the chief salt deposits and sources in the Empire, extracted the salt and sold it from its storehouses. The salt extracted from private sources, could be either sold by the proprietor, to the State at a fixed price, or to private individuals. But in the latter case a poudal tribute had to be paid to the State, the extent of which was determined annually. The deficiencies of this system made the Government renounce keeping the chief salt operations in its hands, and in 1862 the excise system was introduced. The Government gradually ceased its salt operations and handed over the State salt deposits to be rented and worked by private individuals. The salt extracted by them, on both private and State property, was subject to a tax, from which however the salt employed in feeding cattle and in the technical and manufacturing industries was exempt.

Salt imported was subjected to a duty of 38.5 kopecks per poud. With the introduction of the excise system upon salt, the private industry began to develop rapidly, so that the supply for the people was accomplished by a method of free trade throughout the Empire. The revenue brought to the Government by the excise dues upon home production of salt in some years exceeded ten million roubles. However, on January 1, 1881, the Government, wishing to aid the poorer classes in obtaining an object of first necessity and to develop the breeding of cattle, the fish trade and certain

branches of the manufacturing industries together with the improvement of agriculture, abolished the excise system entirely and lowered the duty upon salt imported to twenty kopecks a poud. This measure gave a great impetus to the growth of the salt industry in Russia. Since the abolishment of the excise system the production of salt has fluctuated in the manner shown by the accompanying table.

Years.	Rock salt.	Lake salt.	Evaporated salt.	Total.
		Pouds.		
1881	4,200,700	29,713,300	16,820,300	50,734,300
1882	5,538,900	79,059,300	17,171,400	101,769,600
1883	7,301,800	44,173,000	17,997,400	69,472,200
1884	9,613,500	32,724,800	20,163,000	62,501,300
1885	11,155,000	36,078,300	21,947,000	69,180,400
1886	14,045.800	38,289,500	20,730,700	73,066,000
1887	15,950,800	37,148,300	17,517,000	70,616,100
1888	13,978,600	33,646,200	20,326,300	67,951,000
1889	14,704,900	47,678,600	22,738,700	85,122,200
1890	13,213,000	47,540,800	24,103,400	84,857,200

It is interesting to compare the present yield of salt with that of thirty years ago, before the introduction of the excise system. In 1860 the production of salt was as follows: rock salt 1,352,200 pouds, lake salt 17,157,200 pouds, evaporated salt 7,723,200 pouds, in all 26,232,600 pouds. Thus, between 1860 and 1890 the greatest increase observed in the yield of rock salt is 880 per cent; in the yield of evaporated salt, 212 per cent, and in that of lake salt, 175 per cent, while in general the total production has increased by 234 per cent during thirty years. During the last ten years, that is, since the abandonment of the excise system, after a considerable increase followed by a considerable fall in the price of salt in 1882, the production, especially of lake salt, decreased greatly. Since 1883, however, the growth of the output has proceeded far more uniformly.

From this general description of the salt industry of Russia a review of the chief deposits and sources, and of the markets at their disposal, may be given.

It has already been said that lake Elton is the richest of all the salt lakes of the government of Astrakhan. The extraction of salt from this lake has been carried on from ancient times on a very great scale, but the yield of salt has fallen with the development of the exploitation of the Baskounchak lake, which owing to its shorter distance, fifty versts, from the Volga, and its connection with this main water way of Russia by a railway, is now worked in preference to the other Astrakhan lakes. In 1866 lake Elton alone yielded 5,842,800 pouds, out of 9,146,000 pouds of salt extracted in the government of Astrakhan, while no salt at all was then extracted from lake Baskounchak. In 1870, lake Elton gave 1,015,400 pouds and lake Baskounchak, 1,279,000 pouds, however after a space of ten years, in 1880, only 595,600 pouds of salt were extracted from lake Elton and the exploitation of salt from lake Baskounchak had risen to 10,093,000 pouds. In 1882 the extraction of salt from lake Elton ceased entirely, while in 1890 the yield of lake

Baskounchak amounted to 12,800,000 pouds, and in 1889 it equalled 13,756,700 pouds. In general, in 1890 the salt lakes of the government of Astrakhan yielded 16,866,500 pouds of salt, although there had been years, for instance 1882, when the production was a little under twenty-six million pouds. A large proportion of the salt extracted from the Astrakhan lakes is consumed by the local fish industries of the Volga and Caspian Sea, where herring and salmon are caught in large quantities, and preserved chiefly with Baskounchak salt, while the cheaper kinds of fish are cured with the less pure salt of other lakes. The Astrakhan salt is also transported up the Volga, whence it is carried by rail into the central governments of Russia, as far as those points were it encounters the competition of the Perm, Bakhmout and Crimean salts.

Although the Crimean industry does not include such rich sources of salt as the Elton and Baskounchak lakes, yet its total yield is also considerable. Owing to the insufficient concentration of the lakes of southern Russia, the local salt workers are obliged to expend more labour and capital in exploiting the salt, and to construct artificial salt depositing basins for which there is no necessity in Astrakhan. The Government, which owns a considerable number of the Crimean salt lakes, leases them out at a poudal royalty varying between one and four kopecks. The most productive of all the Crimean lakes are those of Saksk and Sassyk-Sivashsk belonging to the Government. In 1890 the former yielded 3,455,000 pouds and the latter, 1,779,000 pouds. Of the private lakes the following are the most important: the Crim-Eliysk, yielding 2,026,000 pouds and the Chongarsk, 3,600,000 pouds. Altogether in 1890 the Crimean lakes yielded 23,519 800 pouds of salt, while those of the governments of Kherson and Bessarabia gave 1,708,800 pouds of self-deposited salt.

The salt extracted from these lakes is consumed in the south of Russia, where the people have been long accustomed to use self-deposited salt in preference to the rock salt of the Bakhmout basins, which has, however, barred the transport of Crimean salt to the interior of Russia. The competition of the Slaviansk-Bakhmout basin obliged the Crimean salt workers to seek fresh markets for their salt, and therefore they took advantage of the cheap sea freights and began to transport a portion of it by water from the Black sea to the ports of the Baltic, where the Crimean salt has supplanted the foreign product. The amount of salt brought by this route to St. Petersburg, Reval, Riga and Libau amounts to four million pouds. The Crimean salt is transported by rail from the Baltic ports towards the regions supplied with Donets salt. The self-deposited salt extracted in the Don province, Urals, Tourgai and Transcaspian and Fergan provinces, and also in various parts of the Caucasus and Siberia, has only a local importance.

Next to the lake salt, the largest yield falls to the evaporated salt, obtained by means of bore-holes, from which brine of the strength of 12 to 26° Baumé is pumped and evaporated. Owing to the cheapness of wood fuel this mode of extraction is more advantageous than the mining of rock salt from beds lying at a great depth. The most favourable combination of the necessary conditions for this process is found in the government of Perm where it has been practised since the middle of the sixteenth century. The brine is here pumped from a depth of 30 to 105 sagenes. In Count Strogonov's works, eleven beds of salt having a total thickness of 21 sagenes were encountered in sinking a bore-hole to a depth of 105 sagenes. Altogether in 1890 the Perm salt industry yielded 17,981,000 pouds of evaporated salt, the brine being obtained from 66 bore-holes and wells. The salt produced at the Perm evaporating works, besides going to the north,

penetrates far into the interior, thanks to the cheap water route along the Kama and Volga and their tributaries.

Second to the government of Perm, the evaporation of brine is carried on to a large extent in the governments of Kharkov and Ekaterinoslav, in the Slaviansk-Bakhmout salt basin, where in 1890 there were twenty-one salt works at Slaviansk and one at Bakhmout. All these works are situated close to the Donets coal basin and therefore enjoy the advantage of cheap mineral fuel. The brine which is pumped varies in strength, but is chiefly between 22 and 23° Baumé. In 1890, 4,990,400 pouds of salt were produced at these works. Besides having a local demand this salt is consumed in the central and northern governments of Russia. The remaining evaporating works of European Russia and Siberia yield inconsiderable quantities of salt and have only an exclusively local importance.

As has been already remarked the deposits of rock salt in Russia are of enormous extent, but for various local reasons their exploitation has not yet obtained large dimensions, although during the last ten years the production has risen somewhat rapidly. In 1890, eighty-one per cent, or 10,789,900 pouds, of the total yield of rock salt, fell to the Bakhmout salt basin, where there are now altogether four mines, two of them having a total output of 7,500,000 pouds, belonging to a French company, and one to a Dutch company. The Bakhmout salt is distributed in all directions, except to the south, where it rapidly meets the competition of the Crimean salt. But it especially finds a market in the western zone of Russia and in Poland, where the inhabitants have long been accustomed to use rock salt, which was at first obtained from Velichki in Austria and afterwards also from Prussia where a large deposit of rock salt was discovered at Inovratslavel near the Russian frontier. Messrs. Lubimov & Solvey have recently constructed soda works near the Bakhmout salt mines, for treating the local material. In 1890, the Ilets rock salt mine in the government of Orenburg yielded 1,243,600 pouds and in the Caucasus three mines in the government of Erivan gave 784,300 pouds, and two in the province of Kars, 395,200 pouds of rock salt. The salt of these deposits is consumed locally.

In 1890 the total amount of salt consumed in Russia was 85,450,000 pouds which, taking the population as 117 millions, equals 29 pounds per capita. In 1890, nineteen thousand men were employed in the extraction of salt in Russia.

And now it remains to cite the data for the importation of salt from abroad. The following table shows the variation of the import of foreign salt into European Russia during the last ten years.

Years.	Import of salt.	Years.	Import of salt.
	Pouds.		Pouds.
1881	11,368,800	1886	1,202,100
1882	10,290,700	1887	473,700
1883	9,469,900	1888	689,200
1884	4,566,300	1889	1,400,900
1885	2,147,100	1890	1,049,500

The following table, showing the gradual decrease of the importation of foreign salt to the Baltic ports and Western frontier during the last seven years, will illustrate what

was said above respecting the gradual spread of the salt industry, and chiefly of the Bakhmout district, towards the western parts of the Empire, and also respecting the carriage of Crimean salt by sea to the ports of the Baltic.

Import of salt.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
To Baltic ports	1,376,300	191,500	162,800	88,900	102,400	99,500	146,300
Across the western frontier by land	3,032,500	1,724,500	918,200	332,600	503,200	1,177,800	714,300

This salt was chiefly supplied by the following countries and in amounts as enumerated below.

Countries.	Importation of Salt.						
	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Great Britain	1,191,900	462,500	235,600	116,600	164,200	147,400	181,400
Germany	1,890,600	904,500	517,100	129,500	291,500	990,400	618,700
Austro-Hungary	780,400	553,300	313,600	98,000	89,000	129,200	112,600
Roumania	—	148,600	124,800	118,800	130,600	123,200	119,300
France	—	7,700	7,500	—	6,300	4,000	—

According to the customs tariff of 1891 the following duties were placed upon the imported salt:

1. By sea and by land, with the exception of those localities mentioned in the following clause, 20 kopecks per poud.

2. To the ports of the government of Archangel, 10 kopecks per poud. According to the same tariff the importation of salt for curing fish is allowed duty free, on the Mourman coasts of the government of Archangel.

Besides common salt, glauber salt to the amount of about half a million pouds, is extracted from several lakes in the Caucasus and in western Siberia.

Naphtha.

Russia possesses numerous, and some of the richest, naphtha springs in the world and indeed the naphtha industry is one of the most important of all the mining industries of Russia. The naphtha deposits of Russia occur either in disconnected, isolated plots or else cover considerable and continuous areas extending over a large surface. The first category includes the deposits lying along the river Ukhta in the government of Archangel, and the Volga and Soka in the government of Samara, also in the southern portion of the government of Kelets, in the provinces of Ural and Turgai, in Turkestan and on the island of Sakhalin. All these localities have been but little explored, and not worked at all, or else worked only temporarily as an experiment.

The chief wealth of Russia in naphtha is concentrated within a vast area along the northern and southern declivities of the Caucasian range. Natural springs of naphtha, bitumenous masses, the evolution of gases and other indubitable signs of the presence

of vast accumulations of naphtha are met with over the whole area from the north-west to the south-east, starting from the peninsula of Kerch. Springs of naphtha are particularly abundant along the extremities of the hills, forerunning the Caucasian mountains. Thus naphtha is met with over the whole of the isthmus of Taman and in the valley of the Kouban river and its left tributaries along the northern declivity of the Caucasian mountains for a distance of 250 versts. Naphtha wells have also been discovered in many localities on the same side of the Caucasus in the province of Tersk, between the rivers Sunzha and Terek, and in the province of Daghestan. On the south side of the Caucasus, naphtha occurs in the government of Elisavetpol, between the towns of Shousha and Elisavetpol in the government of Tiflis, and lastly in the government of Kutais.

But the south-eastern extremity of the Caucasian range, forming the Apsheron peninsula, is the most remarkable for its abundance of naphtha. Evolutions of gas and naphtha commencing at Shemakhi extend past Baku, across the Holy Island and then continue to the sea in the direction of the Caucasus mountains to the east shore of the Caspian ending in the naphtha and naphthalene deposits of the island of Cheleken. The naphtha springs of the Apsheron peninsula are chiefly concentrated in its central portion about thirteen versts to the south-west of Baku between the villages of Balakhany, Sabunchy, Romany and Zabrat and over the neighbourhood of the villages Binagady and Bibi-Eibat. More or less numerous and productive naphtha springs also lie about the neighbourhood of the villages of Sourakhany and Khourdalan, in the Yasamal valley near the borders of Bakhcha and along the shores of the Caspian to the north and from the Apsheron peninsula to the south. Lastly rich sources of naphtha have been discovered to the east of the Caspian in the Transcaspian province.

The presence of naphtha in Russia has been long known, and as early as 1745 there existed works belonging to a merchant named Nabatov for treating raw naphtha, in the Pechirsk district at the mouth of the river Okhta. However, the production in Russia only attained a really commercial importance at the beginning of the present century. By a treaty signed between Russia and Persia at Hulestan on October 12, 1813, the khanates of Baku, Kouban and Derbent were united to the Empire and from that time Russia became the possessor of the rich naphtha sources of the Apsheron peninsula which, as the Arab writer Massoundi states, had been worked since the ninth century, B. C.

At first, however, the naphtha industry of the Caucasus developed very slowly, and up to 1860 the yearly yield did not exceed 250,000 to 300,000 pouds. The reason of this apparently strange phenomenon was chiefly due to the fact that, after making a few unsuccessful attempts at exploiting the naphtha sources itself, the Government decided upon a farming-out system, without giving sufficient liberty to private enterprise. Another important circumstance was that the preparation of lighting oil from the raw naphtha was unknown before the middle of the present century. Although about 1823, Doubinin Brothers made a successful attempt at Mozdok, to obtain an oil fit for lighting purposes from raw naphtha, still the industry which they had thus started did not attract sufficient attention and was soon given up, so that until 1860, the naphtha was exclusively employed in the raw state either for burning or as a coarse lubricant, thus accounting for its small demand.

The success of the photogene production in Germany gave an impetus to the Caucasian naphtha industry. In 1860 a refinery was started at Sourakhany, and

Cartographical works, A. Jlyne, St. Pbg.

PETROLEUM REGION

in 1864 the Baku works were inaugurated, owing to which the demand for naphtha became larger and its production gradually increased. Thus in 1863 the yield of naphtha was 340,000 pouds, in 1867, 999,000 pouds and in 1870, 1,704,000 pouds.

In 1864 also, exploratory borings were first conducted in the Caucasus in the province of Kouban. The first successful well was finished in 1866 in the valley of the river Koudako, which gave the first naphtha fountain in the Caucasus. However the naphtha, although abundant, was heavy and unsuitable for use. Further boring, to a depth of 570 feet, showed the presence of a light naphtha, and the explorations made in the valley of the river Kouban and its tributaries showed that the discovery of naphtha might be expected over nearly all the district. Lastly in 1871, the first well was sunk in the Balokhan district and although its productiveness did not exceed that of the richer springs, still the advantages of borings over the primitive diggings became evident.

The above mentioned circumstances convinced the Government of the necessity of removing the petroleum districts of the Caucasus from the exclusive enjoyment of the farmer to whom they were leased and to render them free to all desirous of exploiting them. The farming-out system was abolished by a law dated February 1, 1872, and according to the general fundaments of the mining legislation, the naphtha industry was pronounced free. By the same law, the refining of naphtha and the manufacture of photogene was subjected to excise. In acting thus, the Government was not misled in its calculations of founding an important economical and commercial industry, conducive to the interests of the State.

The publication of the law of February 1, 1872, was immediately followed by brilliant results; the public auctions of the State naphtha springs in the Caucasus, previously held by the farmers, exceeded all expectations. All the naphtha sources of the Bolokhana district were divided into seventeen lots, about ten dessiatines each, with one or more wells in each. At the auctions, allotments valued at 523,300 roubles, were sold for 2,851,200 roubles

Notwithstanding the high prices given for the allotments, the buyers quickly set themselves to the exploitation of the naphtha, and instead of digging, sank wells to a greater depth and thus attained striking results. The production of naphtha began to increase rapidly, in a manner which could in no way have been looked for. The exploitation of naphtha was also begun on private lands, and the industry became still more animated owing to the energetic borings made by the proprietors of naphtha-bearing land, among whom a competition soon sprung up. The appearance of the first naphtha fountain in this district in 1873, produced an entire revolution in the industry. The price of naphtha, which in the beginning of 1873 stood at 45 kopecks a poud, immediately fell to two kopecks. This fountain presented an exceedingly tempting phenomenon to many, and although a portion of the naphtha it threw off was lost, it did not retard the search for fresh deposits, but on the contrary strengthened the faith in boring as the best means of attaining quick wealth. The rapidity of the growth of the production of naphtha in Russia, during the first years after the publication of the freedom of the industry, is seen from the fact that up to 1872 the entire production of the Empire did not exceed 1,750,000 pouds, while in 1873 the Bolakhana and Sabouncha districts alone yielded 3,951,600 pouds, 4,862,600 pouds in 1874, and 5,809,000 pouds in 1875. The publication of the freedom of the naphtha industry not only facilitated the rapid increase of the production of raw naphtha, but under favourable conditions also conduced to the development of the manufacture of photogene, and many works were built for the distillation of the product.

The appearance of a series of abundant naphtha fountains, put an end to the hope of a rise in price owing to increased demand. The Baku market had always a surplus over the demands of the local refining works, and as early as 1875, when the yield did not yet exceed six million pouds, there was a crisis in the Baku naphtha industry followed by the stoppage of many of the refining works. In 1877 the Government with a view to develop the industry, decided to abolish the excise upon photogene.

From this time the Baku naphtha industry made rapid strides forward, and in 1888 had attained such dimensions that the Government saw the opportunity of placing a moderate excise upon naphtha lighting oil. In 1887 the yield of naphtha was 167,000,000 pouds and 46,000,000 pouds of lighting oil had been prepared. This excise, to the amount of forty kopecks per poud upon ordinary light kerosene, and thirty kopecks upon the less dangerous heavy lighting oil, did not evince any unfavourable influence upon the now firmly established industry, and in 1890 the yield of lighting oil amounted to seventy million pouds; that is, it increased fifty per cent over the production of 1887. In 1890 the revenue brought to the Government by the excise upon naphtha oil exceeded ten and a half million roubles.

Notwithstanding the favourable results attained by the publication of the freedom of the naphtha industry, a twenty years application of the regulations published in 1872 showed the existence in them of many imperfections and wants whose completion was desirable both in the interests of the naphtha industry and of the State. Therefore, these regulations were revised and replaced by new ones on the 3rd of June, 1892. Based as before upon the freedom of the industry, the new regulations gave greater advantages to the discoverers of naphtha sources, facilitated the conditions of leasehold of State naphtha bearing lands, removed impediments to the laying down of pipe lines over State and private properties, established measures for preserving the industry from the dangers of fire, took measures against the rapacious and irregular exploitation of the naphtha sources, and gave a definite organization to the periodical meetings of the naphtha traders for discussing the general needs of the industry.

The following table shows the growth of the yield and of the refining of naphtha during the last ten years.

Years.	Naphtha.	Lighting oil.	Benzine.	Lubricating oil.
	P	o	u d	s.
1881	40,474,731 *	12,840,656	2,922,815	
1882	50,507,723	16,427,776	—	1,781,494
1883	60,375,970	15,145,401	49,544	3,044,220
1884	90,229,812	20,340,544	151,000	3,406,346
1885	116,258,915	34,148,176	41,072	2,963,838
1886	120,410,927	37,837,306	61,280	2,526,500
1887	166,868,759	46,108,648	242,263	4,003,453
1888	194,341,955	52,120,653	144,157	3,713,452
1889	202,127,942	64,992,245	111,095	3,157,418
1890	242,941,629	69,973,884	124,892	5,374,000

* In the case of naphtha of sp. gr. 0·87, one poud corresponds to 4·94 American gallons.

Thus during the last ten years the production of naphtha increased six times and the preparation of lighting oils, nearly as much.

The accompanying table shows the yield of naphtha in the different governments and provinces during the last two years.

Governments and Provinces.	Yield of naphtha, in pouds.	
	1889.	1890.
Gov. of Baku	200,116,300	240,380,924
Prov. of Kouban	1,381,942	1,813,327
Transcaspian Prov	286,400	285,000
Prov. of Tersk	275,721	370,800
Gov. of Tiflis	55,296	46,444
Prov. of Daghestan.	3,955	2,780
Gov. of Tauride	3,603	29,168
Gov. of Elisabetpol.	3,000	11,000
Prov. of Fergan	1,425	2,106
	202,127,942	242,941,629

The above figures show that the first place in the Russian naphtha industry is occupied by the government of Baku, or strictly speaking, by the Apsheron peninsula, where 99 per cent of the total yield is produced. Hence an examination of the data respecting this district will be of the greatest interest and importance.

The Apsheron peninsula presents an uneven and, in general, but little elevated surface; in places it is intersected by shallow but rather wide and sometimes contracted valleys. It is chiefly covered with sand, and only partially by salt marshes, salt lakes and mud volcanoes. In its geological structure the peninsula is exclusively formed of post-tertiary and tertiary formations the oldest of which are marles and schists of the upper eocene period. The stratification of all these formations are broken, the dislocations appearing in two predominating directions north-west and north-east. In the majority of cases the natural outflow of naphtha appears on the sides or crests of anticlinal curves or in narrow and deep anticlinal valleys of rupture. The naphtha lies in oligocene formations and is chiefly concentrated in sands and friable sandstones. The total thickness of the naphtha bearing tier of oligocene is not less than eight hundred and fifty to a thousand sagenes; and the thickness of the actual naphtha bearing sands and sandstones extends to 150 sagenes.

The quality of the naphtha varies considerably, and starting from an immobile black viscous mass of specific gravity 0·96 it passes through all the transitions to a mobile, light yellow liquid of specific gravity 0·85 to 0·885, having a peculiar odour, dichroism and fluorescence. In its chemical composition the Baku naphtha presents a mixture of hydrocarbons, in which the unsaturated hydrocarbons of the series C_nH_{2n} predominate. These hydrocarbons are known as the olefines and resemble the hydro-aromatic hydrocarbons in their properties.

The Balakhana-Sabouncha naphtha, on being destilled in the usual manner, that is, without crocking, gives:

Light oil (benzene, gazolene)	5— 7 per cent.
Kerosene	27—30 » »
Solar oil (heavy lighting oil)	13—15 » »
Lubricating oils: spindle oil	7 » »
» » machine oil	18—25 » »
» » cylinder oil	2— 5 » »
Vaseline	1 » »

In the preparation of kerosene only, the majority of works obtain:

Kerosene	35 per cent.
Refuse	55 » »
Light oils and waste	10 » »

The heating power of the naphtha, on the average, equals 11,370 calories. The amount of ash does not exceed 0·09 per cent.

The naphtha is exploited by borings, generally made by means of rigid rods with free falling tools; the rope system of boring is rarely employed owing to the local conditions being unfavourable to it.

In 1890 there were 105 allotments under exploitation in the government of Baku. The total number of wells was 376, each well, therefore, yielding on the average 644,452 pouds of naphtha. It is remarked that, in general, the average productiveness of the wells has fallen somewhat. The depth of the newly sunk holes has at the same time increased. In 1881 the average depth of the new wells did not exceed sixty sagenes, but in 1890 it already attained 107 sagenes. A considerable amount of naphtha is thrown up in the form of fountains and during the last few years they yielded as follows:

Years.	Yield of fountains.	Percentage of total production.
1887	68 million pouds	42 per cent.
1888	73 » »	40 » »
1889	42 » »	22 » »
1890	49 » »	22 » »
1891	39 » »	10 » »

The naphtha is stored in various ways, the most usual method is in earthern and stone warehouses having a capacity of as much as eleven million pouds, or in iron reservoirs holding as high as five million pouds. The stores of naphtha are not as a rule large, and rarely exceed nine to ten million pouds. The oil is supplied to the Baku works by means of twenty-five pipe lines having a total length of 260 versts and capable of supplying up to one and a half million pouds daily. In 1890 there were 224 refining works, 148 of which were situated in the neighbourhood of Baku and the remainder in various parts of European Russia. Of the Baku works, 135 were small, and 13 were constructed on a larger scale; the latter gave three-fourths of the total production of naphtha products in Baku.

The largest works belong to the Nobel Brothers; in 1890 these works produced 17,964,400 pouds of various petroleum products. In 1890 the naphtha industry of Russia employed 10,503 men, of which number 4,509 belonged to the refining works.

Lighting and lubricating oils and other naphtha products are chiefly transported from Baku to the interior of Russia in tanks, by the Caspian Sea to Astrakhan, thence also in bulk up the Volga, and then by rail in cistern trucks over the whole of Russia. Another portion is carried by rail from Baku to Batoum, whence it is transported in tanks to the various ports of the Black Sea and Sea of Azov for home consumption, or else in all directions abroad. Before being transported, all the lighting oils are tested on the spot of their preparation by Government agents and, according to the law of March 8, 1886, oil with a flash point of under 28° Celsius (Abel-Pensky's apparatus) is pronounced dangerous and only admitted for sale under certain limiting conditions. In 1890 the official data show that 29,963,260 pouds of lighting oil, or about 43 per cent of the annual production, went to home consumption. Taking the population of Russia in 1890 at 117 millions, the consumption per head comes to 10·2 pounds.

Besides being a cheap mode of illumination, mineral oil now plays an important role as a fuel. It is only natural that the boilers used in the production of naphtha should be heated by no other fuel, the naphtha thus consumed amounting to 11,781,000 pouds. The large quantity of refuse obtained at Baku is partially consumed on the spot, and a comparatively small quantity is sent abroad, but the chief amount is transported to the interior where it is used as fuel. At the present time not only the steamers navigating the Caspian, but also the majority of those upon the Volga and its chief tributaries, employ naphtha fuel, and the amount of naphtha refuse thus consumed equals about fifty-eight million pouds.

There are very accurate data respecting the consumption of naphtha refuse for locomotives, and the quantity thus employed steadily increases every year, clearly showing the advantages offered by this class of fuels. The following are the data published by the Ministry of Ways of Communication respecting the consumption of naphtha fuels on the railways:

1881	115,600 pouds	1886	5,788,500 pouds
1882	131,900 »	1887	6,741,000 »
1883	1,720,400 »	1888	8,707,600 »
1884	3,887,200 »	1889	12,994,100 »
1885	5,042,700 »	1890	17,654,600 »

Independent of this, naphtha refuse has in recent years been applied to all kinds of industrial works, not only locally along the Volga but also in the central governments of Russia. Here naphtha fuel is used not only for heating boilers, but also in metallurgical furnaces in the manufacture of iron. In the Caucasus also, naphtha refuse is employed in copper smelting. According to the data of the Ministry of Finance, the consumption of naphtha fuel by all classes of industries in Russia amounts to eighteen million pouds a year. In 1889, Baku shipped 88,836,400 pouds of naphtha refuse and in 1890, 96,905,900 pouds. A very small portion of this amount was transported to Batoum and all the remainder was consumed in the interior of Russia chiefly as fuel, only a small quantity being converted into other products.

As regards the external trade in naphtha products, in 1873 the importations of volatile lighting oils into Russia amounted to about three million pouds, but since then and especially since 1882 it has steadily fallen, and during the last four years has reached a minimum, as the following table for the last ten years shows.

Years.	Lighting oil.	Raw naphtha.	Years.	Lighting oil.	Raw naphtha.
	Pouds.			Pouds.	
1881	1,298,500	27,250	1886	40,700	59
1882	1,032,300	15,550	1887	15,000	37
1883	389,300	19,200	1888	11,400	110
1884	181,600	14,100	1889	16,200	111
1885	118,100	1,550	1890	15,100	12

The almost total cessation of the importation of American lighting oil into Russia is explained by the rapid growth of the output of all kinds of naphtha products, and chiefly of lighting oil, and also by the excess of their production over the requirements of the interior of Russia.

At the same time the exportation of naphtha products has rapidly increased as the following table indicates.

Years.	Raw naphtha.	Lighting oil.	Lubricating oil.		Naphtha refuse.
			Refined.	Unrefined.	
	Pouds.				
1881	182,600	134,500	309,100	276,800	67,000
1882	112,000	228,700	327,100	376,200	77,500
1883	283,700	1,493,700	454,300	1,266,700	60,400
1884	602,800	3,948,900	604,800	853,000	451,700
1885	1,129,300	7,269,500	648,200	1,490,400	208,200
1886	1,257,800	9,195,300	776,300	1,452,200	2,255,600
1887	1,078,100	11,819,500	1,136,600	1,664,400	3,281,700
1888	299,400	27,363,300	1,515,700	1,281,600	4,481,300
1889	224,700	34,989,400	1,527,800	1,926,800	6,129,500
1890	760,700	39,767,200	3,433,500	1,133,700	2,986,400

The figures of this table clearly indicate the importance of the naphtha industry of Russia. Indeed, while in 1873 when the largest amount of naphtha products were imported, Russia paid over ten and a half million roubles for lighting oil and raw naphtha of foreign production, and in 1890, on the contrary, she exported various naphtha products of home production, to the value of over twenty-seven and a half million roubles. Of all the naphtha products the Russian lighting oil has the widest market.

In 1881 the export of this oil amounted to 134,500 pouds, and after a space of ten years, in 1890, it increased to 39,767,200 pouds; the relation between the total production of lighting oil and the amount exported in 1890 is about 57 per cent. The exportation of lubricating oils, which in 1881 amounted to only 585,900 pouds, rose to 4,567,200 pouds in 1890. With respect to lubricating oils it must be remarked that at first more unrefined than refined oil was exported, but recently there is observed an evident preference for Russian refined oil, which in 1890 amounted to three-quarters of the total of lubricating oils exported. It is interesting to observe which are the chief foreign markets for the Russian naphtha industry, and this is shown in the following table giving the data for the last three years.

Countries.	Lighting oil and benzene.			Lubricating oils.						Naphtha refuse.		
				Refined.			Unrefined.					
	1888.	1889.	1890.	1888.	1889.	1890.	1888.	1889.	1890.	1888.	1889.	1890.
	Produced.											
Great Britain . .	6,019,926	6,865,848	7,822,022	233,651	76,480	586,465	193,081	231,951	156,357	393,381	474,981	557,599
Austria	3,941,747	4,009,675	5,831,271	85,230	72,661	149,950	239,310	87,010	26,512	3,199,124	4,464,588	888,411
Germany	2,775,549	2,783,058	1,876,120	269,797	271,200	750,053	309,003	553,284	298,423	302,907	421,758	198,879
France	169,593	45,480	151,120	433,794	498,955	672,814	217,547	490,220	263,918	193,250	236,657	469,647
Italy	449,142	2,042,260	2,601,376	42,652	26,444	79,941	12,365	33,512	7,320	39,702	28,645	42,770
Belgium . . .	1,508,447	1,841,428	1,088,704	214,308	277,059	871,659	58,165	123,966	83,795	230,749	346,988	606,515
Holland	471,257	537,842	432,590	33,718	135,433	41,425	176,647	210,830	163,662	30,500	—	22,575
Roumania	279,406	526,784	—	10,594	28,073	6,414	44,725	93,440	35,271	—	—	—
Spain	—	519,450	—	10,130	—	68,790	—	—	12,920	—	—	48,000
Denmark	481,527	467,836	354,235	33,718	21,543	18,191	10,133	55,233	49,341	19,703	8,453	26,147
Sweden and Norway .	640,847	413,416	387,674	8,828	5,866	10,034	14,386	16,067	17,474	—	—	—
Greece	12,935	46,174	21,400	—	—	—	—	—	—	—	—	—
Turkey	5,267,431	7,482,907	7,662,780	3,308	—	25,217	—	26,268	—	—	—	—
Persia	291,322	365,525	341,675	—	—	—	—	—	—	56,218	134,706	107,043
India	—	5,201,236	9,913,498	—	—	—	—	—	—	—	—	—
China	—	1,020,290	—	—	—	—	—	—	—	—	—	—
Japan	—	329,750	—	—	—	—	—	—	—	—	—	—

This table shows that the products of the Russian naphtha industry not only find a market in Europe but also in the far east. The chief consumers are those countries to which the naphtha can by carried by the cheap sea route from Batoum, which is connected by rail with Baku, the centre of the industry.

Asphalt.

Asphalt bearing sandstone and limestone occur on the right bank of the Volga in the Syzransk district of the government of Simbirsk, where there are four works for treating the raw material and for preparing bitumen and asphalt compositions, of which they turn out from 750,000 to 1,000,000 pouds per year.

Moreover, the same products are extracted in various parts of the Caucasus, to the amount of over 100,000 pouds annually.

Sulphur.

Deposits of sulphur exist in many parts of Russia, but they have nowhere been fully explored. Thus sulphur occurs on the shores of the Volga, in Poland, the Caucasus, and in the Transcaspian and Fergan provinces. In the government of Kazan, it is known to occur near the village of Sukeevo on the Volga. The ore here lies in druses and interlayers in limestone of the Permian system, whose thickness varies between two and seven feet. The percentage of sulphur in the ore varies between 2·5 and 8 per cent. There formerly existed works for treating the ore, but they are now closed.

In Poland there is a deposit of native sulphur, in the government of Kelets, near the junction of the rivers Nida and Vistula, at the village of Charkovo. The sulphur is here disseminated in a marl of the tertiary system whose thickness varies from one to ten sagenes. The distribution of the sulphur in the gauge is extremely variable, the upper layers generally contain not more than ten per cent, while in the lower it varies from 25 to 75 per cent. Explorations made on the Kharkova mines showed the presence of very considerable stores of sulphur. Works were erected upon the deposit and in 1885 yielded as high as 35,000 pouds. Now these works are closed. Besides the Charkova deposit the geological survey of the same portion of the government of Kelets showed the existence of a fresh bed of sulphur. In the Caucasus native sulphur is found pretty widely distributed over both sides of the mountain chain.

In the province of Daghestan, there is a bed of sulphur belonging to the upper jurassic system, situated about 120 versts to the west of Petrovsk, on the Caspian Sea near the village of Chirkat, in the mountains at a height of 4,500 feet above the level of the sea. The ore here occurs in considerable agglomerations in clay; it contains from 33 to 35 per cent of sulphur. The deposit has been only regularly exploited since 1883, when a French firm, Lescanne Perdoux fils et C°. took over the Chirkat or Khioutsk mine. In 1888 this firm produced 88,000 pouds of sulphur but lately the output has considerably fallen.

Besides the Chirkat deposit, native sulphur is found in other parts of Daghestan and also in the governments of Erivan and Tiflis. A vast bed of sulphur has recently

been discovered and explored in the Transcaspian province about 240 versts from Geok-Tepé and Khiva. In this locality there are solitary, standing hills about 300 feet high, rising in the midst of the uniform sandy steppes. These hills contain nests and veins of quartzose sandstone containing over 60 per cent of sulphur. There are forty such hills, and it has been estimated that each hill could yield as much as thirty million pouds of sulphur, and the local conditions are very favourable to the establishment of sulphur works on a large scale. A deposit of sulphur is also known in the Fergan province where there are works for treating the ore. The following table gives the yield of sulphur during the last ten years.

Years.	Yield of sulphur.	Years.	Yield of sulphur.
	Pouds.		Pouds.
1881	6,500	1886	72,000
1882	39,700	1887	88,300
1883	70,900	1888	22,700
1884	46,100	1889	5,800
1885	108,700	1890	9,800

With such a small home production of sulphur, Russia is obliged to cover its requirements by importation which, during the last five years, is expressed by the following figures.

Years.	Imported.	
	Raw sulphur.	Refined sulphur and flowers of sulphur.
	Pouds.	
1886	484,700	34,300
1887	899,600	64,900
1888	1,363,400	34,700
1889	1,165,900	28,800
1890	1,125,000	28,400

Raw sulphur is imported from Italy. In 1890, 75,300 pouds were for the first time brought from the United States. Refined sulphur chiefly comes from France.

According to the customs tariff of 1891, sulphur imported into Russia is subject to the following duties:

1. Raw sulphur:
   a. Imported to the ports of the Baltic and White Sea, and also by land . . . . . 2 kopecks per poud.
   b. Imported to the ports of the Black Sea and Sea of Azov . 5 » » »
2. Refined sulphur and flowers of sulphur . . . . . 20 » » »

Graphite.

Graphite was first discovered in Russia in 1826. Deposits of graphite are known in various parts of Russia in Europe and Asia; but it has as yet only been exploited in the Kirghiz steppes, in eastern Siberia and in Finland. The deposits of eastern Siberia are especially worthy of attention. In 1856 a Finnish merchant, named Aliber, began to work graphite in the government of Irkutsk, where there is a bed of the highest quality. At one time this graphite was supplied to the well known pencil makers Faber, but at present it is only worked in the smallest quantities to satisfy the wants of the Irkutsk gold melting house, for the manufacture of crucibles. Very vast deposits of graphite of most excellent quality were discovered in 1860 by a merchant named Sidorov, in the north of the government of Yenissei, along the rivers Nizhni-Tougouska and Koureika. The former deposit is estimated to contain ten million pouds of graphite. The high qualities of this ore were certified at the Perm gun factory, and in St. Petersburg, and also in London whither a parcel of it was sent by sea across the Arctic ocean. The situation of these deposits in a distant desert and unpopulated district is the cause of their not being worked.

In general the production of graphite in Russia is subject to considerable fluctuations, and sometimes it is not extracted in the least degree for several years running. Judging from official data the largest amount of graphite was yielded in 1875 when the production amounted to 18,500 pouds. According to the customs tariff of 1891, graphite imported into Russia is subject to duty as follows:

1. Graphite in lumps. . . . . 8 kopecks per poud.
2. Graphite powder . . . . . 30 » » »

Phosphorites.

Phosphorites are known in many parts of Russia, but they are only exploited in the governments of Podolsk, Bessarabia, Kursk and Kostroma. In Bessarabia and Podolia the working area is situated along the shores of the river Dneister and its tributaries. The phosphorites lie in schists of the silurian system and have the appearance of more or less regular spheres from one-half to seven inches in diameter.

Numerous analyses conducted in Austria have shown that these phosphorites are far richer than those of other localities, containing, as they do, 70 to 75 per cent of phosphate of lime, which corresponds to 30 or 35 per cent of phosphoric acid beds. In respect to their size the most important phosphorite beds in Russia are those which occur in the midst of strata belonging to the cretaceous system, where the phosphorite, locally called nugget, is composed of sand cemented together by phosphate and carbonate of lime. In the interior of Russia these beds extend to the northern limit of the cretaceous formations. The richest deposits are situated in the governments of Smolensk, Kursk, Orel and Voronezh; the length of this band is over 600 versts and its width about 150 versts. The percentage of phosphoric acid in the nugget varies from 13 to 27 per cent. In the government of Kostroma the ore contains from 22 to 26 per cent of phosphoric acid.

There are no data giving the total production of phosphorites in Russia and it can only be said that their use is extending more and more in the Empire. But Russian phosphorites also form an object of export as the following data from the official customs statistics show.

Export of phosphorites.	1886.	1887.	1888.	1889.	1890.
		Poods.			
Total	674,900	468,700	448,500	521,100	705,400
Including, to Germany.	10,000	—	—	—	—
» » Austria. .	663,500	468,700	448,500	521,100	705,400

According to the customs tariff of 1891, the exportation of phosphorites in the raw state is restricted by a duty of 12 kopecks per poud; while ground phosphorites are passed free of export dues. On the other hand ground phosphorites imported into Russia are subject to a duty of 2 kopecks per poud in gold.

Precious stones and building materials.

Among the precious stones, diamonds, rubies, sapphires, emeralds, topazes, amethysts, aquamarines, beryls, garnets and alexandrites are found in Russia. Diamonds were first discovered in 1829 in the Krestovozdvigensk gold workings in the central Urals. Subsequently they were also found in working the gold of other mines, but in general, they are of rare occurrence. There are no real diamond mines, and only a portion of the Krestovozdvigensk was temporarily worked exclusively for diamonds. Altogether about 160 diamonds were found, the largest of which weighed about $2^{15}/_{16}$ carats. As yet no diamond bearing rocks are known in the Urals.

Sapphires and rubies are also rarely found in alluvial gold deposits, together with other more or less rare minerals, such as euclase, rose topaz, chrysoberyl, chrysolite, zircon, rutile et cetera. But in the Urals, emeralds occur in quite a different manner. Their deposits form an entire group situated to the north-east of Ekaterinburg. Here exceptionally large crystals of emeralds, chrysoberyl and phenacite are met with in a micaceous schist.

Very fine topazes, beryls and phenacites are found in the southern portion of the Urals, in the Ilmen hills. These stones are also found in the Mourzinsk deposits, situated about a hundred versts to the north-east of Ekaterinburg. The Mourzinsk topazes and beryls are known to the mineralogists of the whole world. The largest topaz known was found here; it is now in the Museum of the Mining Institute, and measures 27 centimetres in length, and 31 centimetres in circumference. Topazes, aquamarines and beryls are also found in the Nerchinsk mountains in eastern Siberia. A crystal of topaz of exceedingly large dimensions was found in one of the gold workings of this locality. In general, garnets are of frequent occurrence in the Urals. Here different varieties of greenish coloured garnets are known. If these stones contain a small amount of chromium they have an emerald green tint, and a very powerful lustre, and indeed exceed the emerald in beauty.

Rock crystals and amethysts are found in many parts of the Urals and Siberian mountains. The Urals long ago attracted attention by their richness in precious and coloured stones, and in 1755 a Government Stone Cutting and Polishing Works was established at Ekaterinburg. At the present time the cutting of the precious stones and the polishing of the various rocks and minerals found in the Urals, is chiefly carried on by the former workmen of the above establishment, which has almost ceased working; the industry has now developed into a rather large peasant occupation (koustarny promyshlennost).

Amber is found in the governments of Courland, Grodna, Kiev, Volynsk, Minsk and Kherson. Moreover, it is cast up by the Baltic Sea in the neighbourbood of Libau and also on the shores of the Arctic ocean at the mouths of the rivers Pechora and Mezen. Those practically useful minerals, which are found as mountain rocks or in the form of more or less considerable masses will now be noticed.

Lapis lazuli is known in several localities about Lake Baikal in eastern Siberia. Malachite is met with in the Urals, frequently accompanied by other copper ores, sometimes in huge blocks. In the Museum of the Mining Institute there is such a block weighing about 90 pouds, which formed part of a still larger block weighing 170 pouds.

Labradorite occurs in the governments of Kiev and Volyn, in considerable masses, subordinate to granite. This stone is used in building, for facing walls and for making ornaments.

Granite occurs in abundance both in the south and in the north of Russia, but it is only regularly quarried in a few places. St. Petersburg is supplied with two sorts: the red or Viborg granite, locally called rappakivi, is quarried in Finland on the shore of the gulf of Finland between Viborg and Borgo; and the gray, so called Serdobolsk granite, is chiefly transported from the neighbourhood of the town of Serdobol on the north shore of lake Ladoga.

The red, large grained Finnish granite or rappakivi is used in large quantities in St. Petersburg; all the quays of the Neva and the canals are walled with it, and the foundations of many buildings as well as all the port and fortifications of Cronstadt are built of it. The most remarkable monolites of rappakivi are those out of which the columns of the St. Isaac Cathedral and the monument of the Emperor Alexander I are made; the latter is 78 feet high and 12 feet in diameter. Besides the granite cut from quarries, there is a large demand for granite cobbles which are found largely disseminated over a great portion of the north and interior of Russia. In the north, huge blocks of granite are sometimes met with, like that which forms the base of Peter the Great's monument in St. Petersburg. The Serdobolsk granite is dark gray, fine-grained, exceedingly hard, and polishes with difficulty. It is used for architectural ornamentation; for example, the huge figures, supporting the portico of the Imperial Hermitage of St. Petersburg are made of it. In the south of Russia, granite is very widely distributed over the governments of Ekaterinoslav, Poltava, Podolsk, Volyn, Bessarabia and Tauride. There are large granite quarries in the governments of Volyn and Podolsk. In the government of Voronezh, there are granite quarries on the banks of the river Don.

Jasper occurs in the Ural and Altai mountains. The largest amount is found on the eastern side of the south Urals. The Kalkansk jasper is the most beautiful. In the Altai a very large number of beds of different kinds of jasper are known and worked up by the local Kolyvansk polishing works into such large objects as the vases, and oval bowl 20 feet across, which are preserved in the Imperial Hermitage.

Marble is found in many parts of Russia, but it is far from being worked in all the localities of its occurrence. There are marble quarries in Finland, in the government of Olonets, in the Urals and in Poland. A white marble is found on the eastern side of the Urals near Ekaterinburg; it is cleavable into pieces up to seven feet long; in the purity of its colour it excels some kinds of Carrara marble. In the government of Olonets there are the Tivdisk marble quarries, which were opened out in the reign of Catherine II, and which have been worked on a very large scale for many monumental works in St. Petersburg, the St. Isaac Cathedral being among them. In Finland there are the Ruskiolsk marble quarries. In Poland, marbles of the most varied colours and designs occur in the neighbourhood of the towns of Kelets, and Hentsina. These marbles have been quarried since the sixteenth century. A black marble is known in the neighbourhood of the town of Olekoush, about twelve versts distant from the Austrian frontier. This marble has also been quarried since the seventeenth century. The ikonostas in the Cathedral of St. Stephan in Vienna is made of it.

Limestones are also quarried in many parts of Russia, as for instance, in the neighbourhood of Moscow, where the Miachkov quarries are the best known. This limestone is distinguished for its whiteness, homeogenuity and purity; it is sufficiently soft to admit of being chiselled, and is therefore used for making ornaments. Calcareous limestone of the tertiary system is largely distributed in the south of Russia, and some towns, as for instance Odessa, are almost entirely built of it; when damp it is very soft and easily disintegrates, but hardens when dried. Marles are used in the preparation of hydraulic cements and occur abundantly in the governments of St. Petersburg and Esthonia. Those found near the town of Novorossisk are remarkable for their high quality, and are used for making Portland cement.

Quartz and quartzose sandstone are also known in various parts of Russia. The government of Olonets is especially rich in them. The dark red Shokshink quartzose sandstone of this locality is used for many monuments, and the tomb of Napoleon I, in the Paris Hôtel des Invalides, is made of this material, the gift of the Emperor Nicholas I. In the neighbourhood of Moscow there are several sandstone quarries which give an excellent building material and grindstone. Such sandstone also occurs in the Urals, in the governments of Kursk, Kharkov, Saratov, in Poland, and other places.

Whetstone is exploited in the governments of Vologda, Ufa and Ekaterinburg. Lithographic stone is found in the governments of Perm and Podolsk. Slate is known in the north of Russia in the government of Olonets, in the south of Russia near the Krivoy-Rog, on the borders of the governments of Cherson, and Ekaterinburg, and also in the Caucasus.

Asbestos and talc occur in various parts of European Russia and Siberia. In the Urals, asbestos is now chiefly extracted in the neighbourhood of Ekaterinburg, and in 1891, 72,000 pouds were taken from that locality.

Gypsum beds are known wherever the Permian system occurs in the east of Russia in Europe; it also lies in the same formation in the government of Ekaterinoslav. Gypsum is known in the Devonian system, in the governments of Pskov, Vitebsk, and Lithuania; it lies in more recent formations in the governments of Poltava and Podolsk and also in Poland.

Chalk is worked in considerable quantities in the government of Simbirsk and Kharkov and in other localities. Among the numerous varieties of clay known in all

the governments of Russia and lying in all kinds of geological formations, the most important, from an industrial point of view, are the china and fire clays.

Kaolin is known in many parts of south Russia where it forms the product of the desintegration of granite and gneiss. Large deposits of kaolin are known in the governments of Ekaterinoslav, Kherson, Kiev, Volyn and Chernigov. In the interior of Russia the Gzhelsk beds of china clay, about 50 versts from Moscow, have been worked for a very long time. Fire clay is also worked in many parts of Russia. The most important are the fire clays of the carboniferous system, which are worked on a large scale in the governments of Novgorod, Tver and Tula. Besides this, fire clay is worked in the governments of Vladimir and Olonets, in the Donets coal basin, and in the western portion of the government of Ekaterinoslav and also in Poland.

According to the official data for 1890, which only include the stone quarries subject to the supervision of the Mining Department, the following number of men were employed in these industries:

In the exploitation of kaolin	760 men.
» » » » fire clays	1,318 »
» stone quarries	16,443 »
Total . . .	18,521 men.

Mineral springs.

By the law of February 19, 1885, for the preservation of mineral springs, the land surrounding the springs is, within a certain area, subject to preservative measures, and the landowner cannot conduct any kind of work upon it without the previous permission of the mining authorities.

Among the numerous mineral springs of Russia the following are included under that law.

In northern Russia: the Starorussk, in the government of Novgorod; the Hillovsk, in the government of Pskov; and the Kashinsk, in the government of Tver; in central Russia: the Lipetsk in the government of Tambov; in western Russia: the Kemmernsky in Lithuania, the Baldonsk in Courland, and the Druskeniksk in the government of Grodno; in Poland: the Tsekhotsinsk, in the government of Warsaw, and the Bussk, in the government of Kelets; in Eastern Russia: the Serghievsk and Stolypin, in the government of Samara; in South Russia: the Slaviansk, in the government of Kharkov, and the Sakskand Chokraksk mud springs in the Tauride government. In the Caucasus there are four groups of the so-called Caucasian mineral waters: the Podkoumsk, in the province of Tersk, the Borzhomsk in the province of Stavropol, and the Abas-Toumansk in the government of Tiflis.

The most important of all these springs are four groups of the Caucasian waters situated near tho town of Piatigorsk.

At Kislovodsk there is one carbonate spring situated at a height of 2,500 feet above the level of the sea, and known as the Narzan spring, whose temperature is about 15° C. The Essentouksk mineral springs lie at a height of 1850 feet above the level of the sea. These springs fall into two groups, one alkaline and the other sulphurous. The spring No. 17 is especially famous for its strength. The Piatigorsk sulphurous

springs are situated in the town of Piatigorsk and its neighbourhood. Here, as at Essentouki, there is a whole series of sulphur springs varying from 29° to 59° Celsius in temperature. The Zhelesnovodsk springs are ferruginous-alkaline, partly hot (50°) and partly cold; there are in all twelve springs here.

All these four groups of the Caucasian springs belong to the State, and in recent years the Government has expended 800,000 roubles in developing them.

Among the remaining above mentioned springs, the Starorussk, Druskeniksk, Tsekhotsinsk, Bussk and Slaviansk are saline; the Hillovsk, Kemmernsk, Baldonsk and Serghievsk are sulphurous; the Borzhomsk, alkaline; the Kashinsk and Lipetsk, ferruginous, and the Stolypinsk, saline-ferruginous.

Without citing all the remaining springs known in European Russia and the Caucasus, it should be mentioned that numerous chalybeate springs are known in Turkestan, in the Altai in Western Siberia, and in the Transbaikal province of Eastern Siberia. The Transbaikal mineral springs are particularly famous. The medicative lake Shiro, in the southern portion of the government of Yenisei, is of great repute; according to the investigations made by the Faculty, the water of this lake contains a larger amount of alkalis and sulphate of sodium than the frequented waters of Carlsbad, Marienbad and Vichy.

ERRATA.

Page.	Line.	Printed.	Read.
1	28	Nikitin	Nikita.
2	46	Derzabin	Deryabin.
3	16	Vernien	Verneuil.
3	20	Monpere	Montpéreux.
12	39	Alekminsk	Olekminsk.
17	12	him.	them.
24	23	Bogoslov	Bogoslovsk.
30	24	Baikal	Transbaikal.
42	33	Don	Donets.
50	16	importation	exportation.
55	21	Don	Donets.
56	6	»	»
56	19	»	»
57	5	»	»
61	27	Zisichansk.	Lisichansk.
63	32	1862	1869.
68	19	Russian Siberia	Prussian Silesia
72	29	and carboniferous	carboniferous and jurassic.
73	16	Zaibaikal	Transbaikal.
75	19	Briansk.	Briantsevsk.
82	4	isthmus	peninsula.
82	18	south-west.	north-east.
82	22 and 23	from the Aspheron peninsula to the south	to the south of the Apsheron peninsula.
93	32	topaz	beryl.
95	36	Ekaterinburg	Ekaterinoslav.
96	35 and 36	the Podkoumsk, in the province of Tersk, the Borzhomsk in the province of Stavropol and the Abas-Toumansk in the government of Tiflis	in the province of Tersk; the Podkoumsk, in the government of Stavropol; the Borzhomsk and the Abas-Toumansk, in the government of Tiflis.